





A GRADUATED COURSE  
OF SIMPLE  
MANUAL TRAINING EXERCISES  
FOR EDUCATING  
THE HAND AND EYE

BY  
W. HEWITT, B.Sc.  
SCIENCE DEMONSTRATOR FOR THE LIVERPOOL SCHOOL BOARD

*COMPLETE*

LONDON  
LONGMANS, GREEN, & CO.  
AND NEW YORK: 15 EAST 16<sup>th</sup> STREET  
1893

*All rights reserved*



## PREFACE.

It is now very generally admitted that the Kindergarten exercises, as carried out in many of the best infant schools, provide an excellent means of education through the medium of the operations performed by the children themselves with the objects comprising the various gifts. And it has been a frequent source of regret that arrangements were not made for continuing such work, in a more advanced form, with the children after they had left the infant school. The great attention which has recently been given to the general subject of technical education has considerably strengthened this feeling, and has led to attempts being made to supply this deficiency in the ordinary school course.

The present scheme of exercises, drawn up at the request of the Liverpool School Board, and successfully introduced into nearly all their schools, is intended to provide a graduated four years' course of practical work for children of from seven to eleven years of age (Standards I.—IV.). It consists of four series of exercises, each series containing thirty exercises, and forming the subject of a year's work. The present volume contains the first and second series; the second part, containing the other two series, is in an advanced stage of preparation.

The author is indebted to several teachers in the Board's Schools, and to the Board's inspectors, for various criticisms suggested in the course of the actual working out of the exercises in the schools.

The exercises involve the use of several different materials—wooden laths, paper, wire, clay, etc.—and this is done partly



for the sake of variety, but more especially in order that the children may become practically acquainted with the different characters of various substances and the different methods of manipulating them. Whilst there is much to be said in favour of confining the exercises to one particular branch of work, and so bringing it to a considerable degree of development and making the children expert in its performance, it is probably wiser in the earlier stages of education to aim at a general all-round development of the powers and faculties, and to specialise afterwards when special tastes and powers begin to show themselves. Should, however, the special opportunities or tastes of any teacher incline him or her to one particular material or kind of exercise rather than another, it would be very easy (with the help of such excellent manuals as Ricks' "Hand and Eye Training") to introduce a number of such supplementary exercises. It is, however, strongly recommended that the full course of exercises here given should be taken, and in the same order.

The great object attempted being to educate the mind through the medium of the hand and eye, the production of objects and designs of beautiful form and colour, while not altogether omitted, is subordinated to the intelligent and accurate performance of each step in the exercise. There is consequently very little show work produced, though quite sufficient in the way of construction of simple objects and designs to maintain the interest of the children.

Experience has shown that the children look forward with delight to these lessons; and I have the authority of teachers in several different classes of schools for the statement, that the exercises, when properly carried out, have the effect of brightening and quickening the intelligence of the children, as well as of developing their powers of observation, and training their fingers.

The exercises have been largely based upon the ordinary drawing exercises, and may in fact be regarded as, for the most part, applied drawing. It will therefore be found that the manual training lessons and the drawing lessons materially assist each other.

The various materials used are such as may readily be obtained ; but Messrs. Philip, Son, and Nephew, 51, South Castle Street, Liverpool, have specially prepared most of the materials and apparatus to meet the wishes of the author.

W. HEWITT.

LIVERPOOL, 1892.



# CONTENTS.

INTRODUCTION . . . . .	PAGE xi
------------------------	------------

## FIRST SERIES.

LIST OF APPARATUS AND MATERIALS . . . . .	3
NOTES ON THE APPARATUS AND MATERIALS . . . . .	4
EXERCISES . . . . .	8

## SECOND SERIES.

LIST OF APPARATUS AND MATERIALS . . . . .	67
NOTES ON THE APPARATUS AND MATERIALS . . . . .	68
EXERCISES . . . . .	70

## THIRD SERIES.

LIST OF APPARATUS AND MATERIALS . . . . .	129
NOTES ON THE APPARATUS AND MATERIALS . . . . .	130
EXERCISES . . . . .	132

## FOURTH SERIES.

LIST OF APPARATUS AND MATERIALS . . . . .	189
NOTES ON THE APPARATUS AND MATERIALS . . . . .	190
EXERCISES IN WIRE MODELLING . . . . .	193
EXERCISES IN CARDBOARD CUTTING . . . . .	205
EXERCISES IN CARDBOARD MODELLING . . . . .	218



# INTRODUCTION.

## TO THE TEACHER.

THE object aimed at in this course is primarily to develop and train certain faculties and powers of the children by means of a carefully selected and graduated series of practical exercises. The activities of the children are enlisted in the service of their intellectual development ; they are set to do something in order that they may (often perhaps unconsciously) learn something.

Although in many cases the completion of the exercise results in the production of some finished object or design, such production is not to be regarded as the chief end and aim of the exercise, and therefore to be accomplished as speedily and as directly as possible. The work will have its full educational value only when the teacher clearly appreciates the principle that each step in the process should involve the action of the mind as well as of the hand ; and that the result hoped for is as much a quickening of the intellectual powers as an increased accuracy of the eye or dexterity of the fingers.

The exercises are intended to cultivate habits of careful attention and correct observation, to train sight and judgment in the estimation of symmetry and accuracy, and to practise the hand in the manipulation of various materials, so as to give concrete expression to ideas of form or position previously existing in the mind. Orderly and cleanly habits of work should be encouraged, and the children should be led to recognize and appreciate what is exact, symmetrical, and harmonious.

Many of the exercises may be regarded as practical applications of the ordinary drawing exercises,—parallels, various angles, triangles, and other geometrical figures, forming the greater part of the constructions to be made. Opportunities will frequently arise where the drawing and manual training may be made to bear directly on each other, the object constructed in the one forming the copy to be reproduced in the other, and *vice versa*. Each subject will thus be a means of imparting increased interest to the work of the other, and promoting its progress.

By frequent use in the practical exercises, the geometrical terms will gradually come to have very definite and real meanings for the children; in some cases more correct than the ideas usually obtained from the ordinary definitions and diagrams. For example, the term “square,” applied to a piece of paper or metal, will become associated in the minds of the children with the idea of surface or area, and not merely be confined to the lines bounding such a surface; while in the same way a block of clay modelled into the form of a cube will give them such an idea of volume or solidity as no verbal definition or perspective drawing could do.

It is, therefore, well to take advantage of every opportunity in the early lessons (and to recur to it frequently in the later exercises) of drawing attention to the more common terms used in describing certain forms and positions, and to note any special properties connected with them,—*e.g.* that all the sides of a square are equal straight lines, the angles or corners equal, the lines from the centre of a circle to the circumference all equal, etc. On the other hand, it is advisable not to introduce more technical terms than are really necessary for the purpose of description, nor to require the children to learn off by heart set definitions of those terms. It cannot be too strongly insisted upon that in lessons such as these we are dealing primarily with *things*; that *words* are used only for convenience in communicating our ideas to each other; and that therefore an accurate personal knowledge of the thing is the first essential, while the term by which it is spoken of must come after and not before such knowledge is acquired.

For the same reason as it is undesirable to load the memories of the children with unnecessary technical terms, so in many of the exercises it is not advisable to confuse their minds by pointing out everything that the exercise might be made to illustrate, as it appears to the much wider knowledge of the teacher. Much of this knowledge, if enlarged upon, would be beyond the present powers of comprehension of the children. It may be expected, however, that such facts and relationships, though not obviously pointed out, will in many cases so impress themselves (unconsciously) upon the minds of some at least of the children, as to bear fruit in due season.

It is hoped that the children will gradually be led by the constant use of the rule for measurement, and the frequent exercises required of estimating distances by the eye, to form approximately correct ideas of the sizes of bodies; and that the expressions, inch, half-inch, three inches, etc., will come to correspond with more or less exact ideas of those dimensions which they have obtained by personal experience.

It is a good plan to spend a little time at the commencement of an exercise in conversation with the children, showing them, when possible, a previously prepared copy of the object or design to be constructed, or a sketch of it on the blackboard and discussing the number, character, and position of the parts of which it consists, their equality, parallelism, etc.,—and also in a brief examination of the materials and apparatus to be employed. The children will thus have in their minds an idea of the object to be accomplished, and a feeling that their work is being carried out in accordance with a previously arranged and intelligible plan, into which they can more or less enter.

The following exercises are set out in such a manner as to show the various steps which each comprises. After each step the teacher should examine the work to see that it has been satisfactorily done before the next step is attempted. And it is very desirable that where a mistake has been made the child should be led to find out the error for himself, by comparison with the copy or of one portion of his work with another, rather than that the teacher should immediately pro-



ceed to point it out. Each step should be illustrated by the teacher performing similar work (on a larger scale, if necessary) in front of the class, or by a sketch on the blackboard.

Each exercise will occupy from thirty to forty minutes, or occasionally perhaps somewhat longer. In case the exercise is not completed by the end of the time set apart for the lesson, it is well to let each child put away his unfinished work, materials, and apparatus in a large brown-paper envelope, having his name written outside; these may then be readily distributed when the lesson is resumed. It will probably be necessary to go over some of the earlier exercises two or, in some cases, three times, before the greater number of the children can do them satisfactorily. The time and trouble so spent will, however, be amply repaid by impressing the children with a sense of the thoroughness and accuracy required even in the most simple operations, and thus leading them to exercise greater care in all their future work. And a very much better educational result would be obtained by accomplishing only a portion of a series in a given time in a thoroughly satisfactory manner, than by getting through the whole series and accepting less perfect work.

Hasty and careless work should in all cases be discouraged; an essential feature of the course being that the exercises, although simple, are to be carried out in as accurate and precise a manner as can reasonably be expected of the children, considering the limited extent of their powers and of the means at their command. The teacher should set up a high standard, and regulate the praise bestowed on the work according to its approximation to this standard. And while selecting any good and completed exercise for special praise (and perhaps, where possible, for preservation with the child's name attached), the children should be given to understand that such work is only what might be accomplished by, and is indeed expected from, every child in the class.

If time permitted, some of the exercises might be repeated by the children from memory, a completed copy of the object being first shown to them. This memory of form is a faculty that it would be well to cultivate.

**A GRADUATED COURSE**  
**OF SIMPLE**  
**MANUAL TRAINING EXERCISES**







FIRST SERIES.



## LIST OF APPARATUS AND MATERIALS.

[The references are to the notes which immediately follow the list.]

Narrow wooden laths, about  $5'' \times \frac{1}{4}''$ . (*Note A.*)

Beads. (*Note B.*)

Small scissors, with rounded ends. (*Note C.*)

Flat wooden rules, 1 foot long, divided into half-inches.

Circular disc,  $3''$  diameter, preferably of metal.

Square,  $\frac{3}{4}''$  side, preferably of metal.

Large plain white paper squares,  $6''$  side.

Small plain white paper squares,  $4''$  side.

Coloured (various) paper squares,  $4''$  side.

Ditto, gummed at the back. (*Note D.*)

Paper strips, white,  $12''$  long, half-inch wide.

Squared paper for drawing (quarter-inch squares), pieces  $5''$  square.

Short lengths (about  $4''$ ) of various-coloured wools in small bag. (*Note E.*)

Teacher's corresponding series of wools in small skeins.

Soft copper or brass wire (about No. 26) in small coils of about 7 feet. (*Note F.*)

Pieces of planed wood, about  $3''$  square,  $\frac{1}{2}''$  thick.

Rings, brass or black, about  $1\frac{1}{4}''$  diameter.

Modelling clay. (*Note G.*)

Earthenware jar with lid, for keeping moist clay.

Small modelling boards, about  $11'' \times 7''$ .

Simple wooden modelling tool. (*Note H.*)

Small sponges.

String, thin for cutting clay, and some thicker for Exercise IX.

Lead pencils.



## NOTES ON THE APPARATUS AND MATERIALS AND THEIR USE.

(A) The *laths* should be of wood which breaks easily and sharply across, not leaving very irregular edges. Narrow strips of paper might be sometimes used instead of the laths, but they are not so convenient.

(B) The *beads* should be of fairly large size, so that they may readily be handled and moved. They should also have a flat side, so as to stand steadily on the table or desk.

If the slope of the desks is so great that much difficulty is found in getting the children to place the beads so that they do not roll off, the exercise might be performed on a modelling board or slate laid on the desk and made as nearly level as possible by placing a book under one edge; or *small* flat buttons or flattened shot might be used on the desks instead of the beads; or the laths or rings might be laid on a slate placed on the desk in the usual way, and the children told to mark points with their slate pencils instead of laying beads.

(C) Small *scissors* with rounded ends can be had for about one penny the pair, and have the advantage that young children cannot hurt themselves with them. They have the disadvantage usually of working somewhat stiffly at first, and care must be exercised when cutting paper with them not to take the cut quite to the end of the scissors, as the ends tear the paper.

(D) The *coloured paper squares* should have a smooth glazed surface, so as to prevent them from being readily marked by the fingers. Those which are coated with gum at the

back are somewhat brittle, and, when folding and creasing them, it should be done with the coloured surface inside.

In mounting the gummed squares on other paper, the children should be made to lay them in position before moistening the gum; and it is then sometimes advisable to mark one or two points at the edges or corners as guides in laying them down again when wet. They may, however, be stuck down by holding them in position, when correctly laid, and raising one corner or edge at a time, moistening it with the sponge and fastening it down before raising another part. Or the paper may be removed, and the whole gummed face wetted by dabbing (*not rubbing*) it with the wet sponge.

The children might be allowed to use pieces of paper (old exercise paper, etc.) to lay over the coloured sheets while rubbing them to fasten them down.

The packets of gummed paper should be kept in a dry place, or they are liable to stick to each other.

The pieces of *wool* should be thick ("fleecy" or "double Berlin"), and about 4 inches long. They should comprise black, white, and two or three shades of red, yellow, green, and blue—in all about twenty specimens. (A special series of wools suitable for these exercises, and used also to illustrate the lessons on colour in the author's "Elementary Science Lessons," has been prepared by Messrs. Philip, Son, and Nephew, South Castle Street, Liverpool. The same firm has also arranged to supply all the other apparatus required for these exercises.) Each child should have a set of wools, which may very conveniently be kept in small calico bags.

A set of small skeins of corresponding colours should be provided for the teacher to use for class instruction.

The children, when sorting the wools, should be provided with a piece of clean white paper on which to lay the pieces, so as better to show the colours.

(*F*) The *wire* must be thin and soft, so that the children may readily work it with their fingers. It may be cut into

lengths with the scissors. Care should be taken to prevent the wire getting into bends or kinks, as it would then be difficult for the children to straighten it out again properly. If it should get somewhat bent, it may be straightened by drawing it over a rounded slate-frame.

- (G) The *modelling clay* recommended is that used by artists, and is best bought in a state of fine dry powder. If obtained in dry lumps, it will be well to reduce them to powder, with a large pestle and mortar if possible. The clay is of a light grey colour, and should be free from gritty particles.

The powder is prepared for use by mixing it with water, just as in making dough, mixing the powder and water well together with the hands, or with a large spoon or stirrer. When properly prepared it will be soft, but not sticky; if it sticks at all to the fingers it is too wet, and some more dry powder should be worked into it. If the bowl or board on which the clay is being prepared is dusted with some of the dry powder the clay will not so readily stick to the article.

When the clay has been once properly made up, it may be kept in good condition for some time by enclosing it in an earthenware jar covered with a lid of the same material. If it is found that the clay is getting somewhat too dry, a damp duster laid in the jar along with the clay will probably soon make it all right.

The pieces of clay, when being worked in the hands, tend to become dry, especially if too small pieces are used. (As a rule, each child should be given for these exercises a piece of clay sufficient to make a ball from  $1\frac{1}{2}$  to 2 inches in diameter, or about as much as would be made from a quarter of a pound of powder.) If it is found that the clay in the process of modelling is getting too dry, the children might be provided with a damp sponge with which to slightly moisten their hands occasionally—not, however, making them so wet that the clay will stick to them. (It is hardly necessary to say that the sponges

should be well rinsed before being used again for paper mounting.)

The modelling should be done on special boards or old slates (without frames), and it is found that, if reasonable care be taken, neither the desks nor the children's clothes need be soiled by the work.

The moist clay may readily be cut with a knife or with a piece of thin string. When the children have to cut the clay in the course of an exercise, they should be supplied with a piece of thin string about six inches long.

(II)•The *modelling tool* is not much required in the simple exercises of the first and second series, almost all the work being done with the finger and thumb. When a cube or other figure with flat sides is to be made, the clay should be pressed or slightly struck against the modelling board; or the small square wooden blocks provided for the purpose may be used, especially where pairs of flat sides parallel to each other are to be produced.

Perhaps the most useful general tool is the one shaped as in the figure.



**Exercise I.****PAPER FOLDING, TEARING, AND LAYING.**

MATERIALS.—*Large white paper square.*

Fold paper down middle, and crease well.

Tear paper along crease. (The creased paper should be held in both hands, with the ridge of the crease towards you, and the tearing gradually started. Then the paper may be laid flat on the desk and one part held down with the hand while the other is torn off.)

Repeat folding and tearing to get eight equal long strips.

Lay strips on desk parallel to each other and at approximately equal distances (Fig. 1).

Take up half the strips, and lay parallel to and equidistant from each other, but perpendicular to the other strips (Fig. 2).

Lay one set over another to form a grating (Fig. 3).

NOTE.—If, as is probable, it is found necessary to repeat this exercise two or three times before the children learn to tear the paper neatly, the manner of laying the strips after tearing may be varied thus:

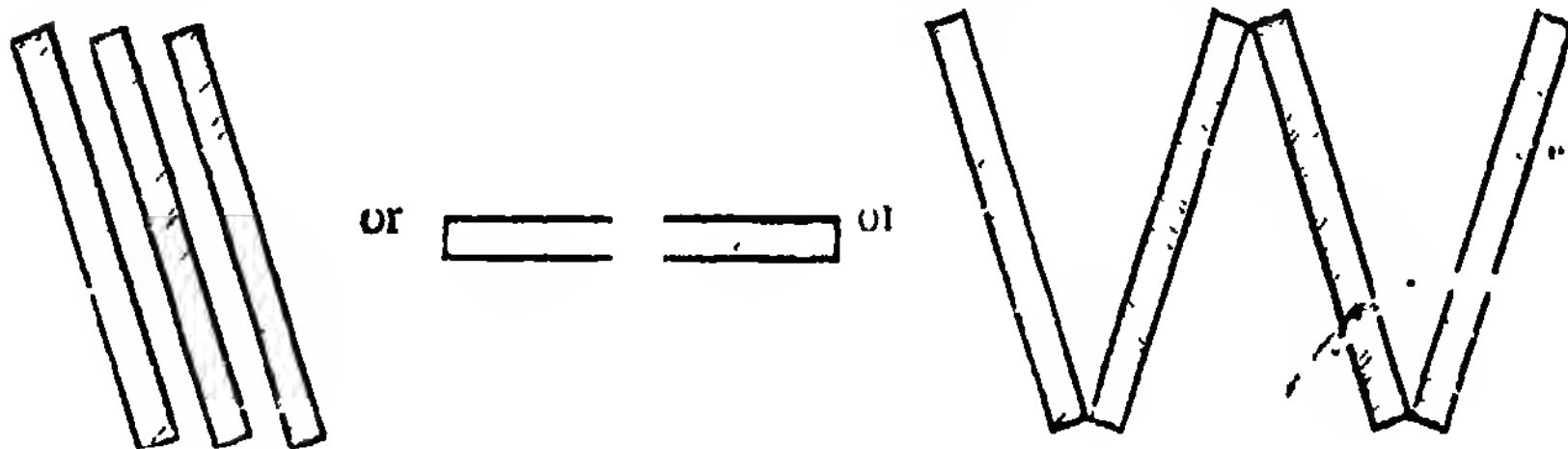


FIG. 1.

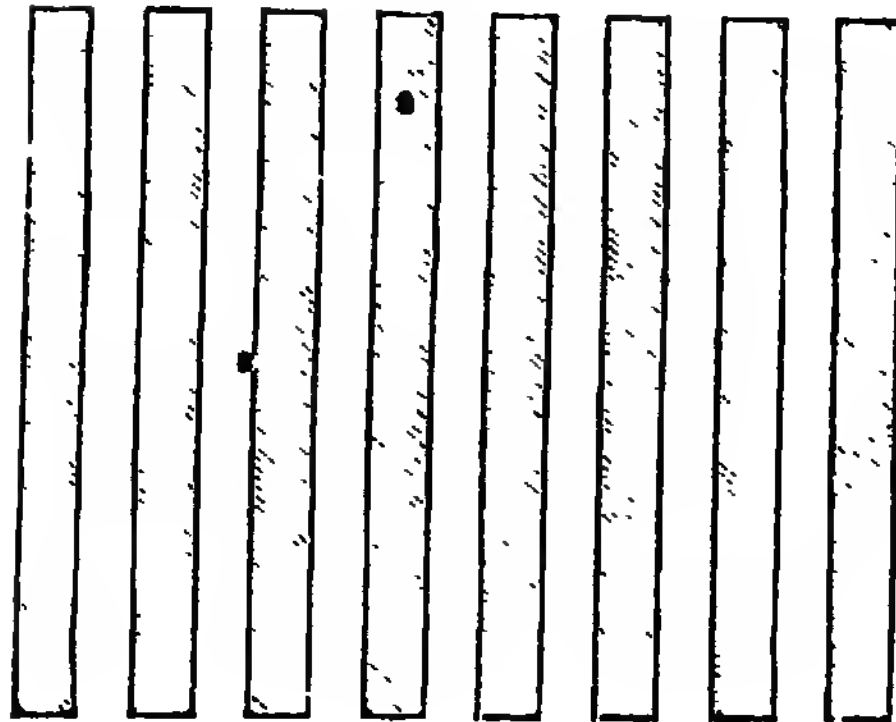


FIG. 2.

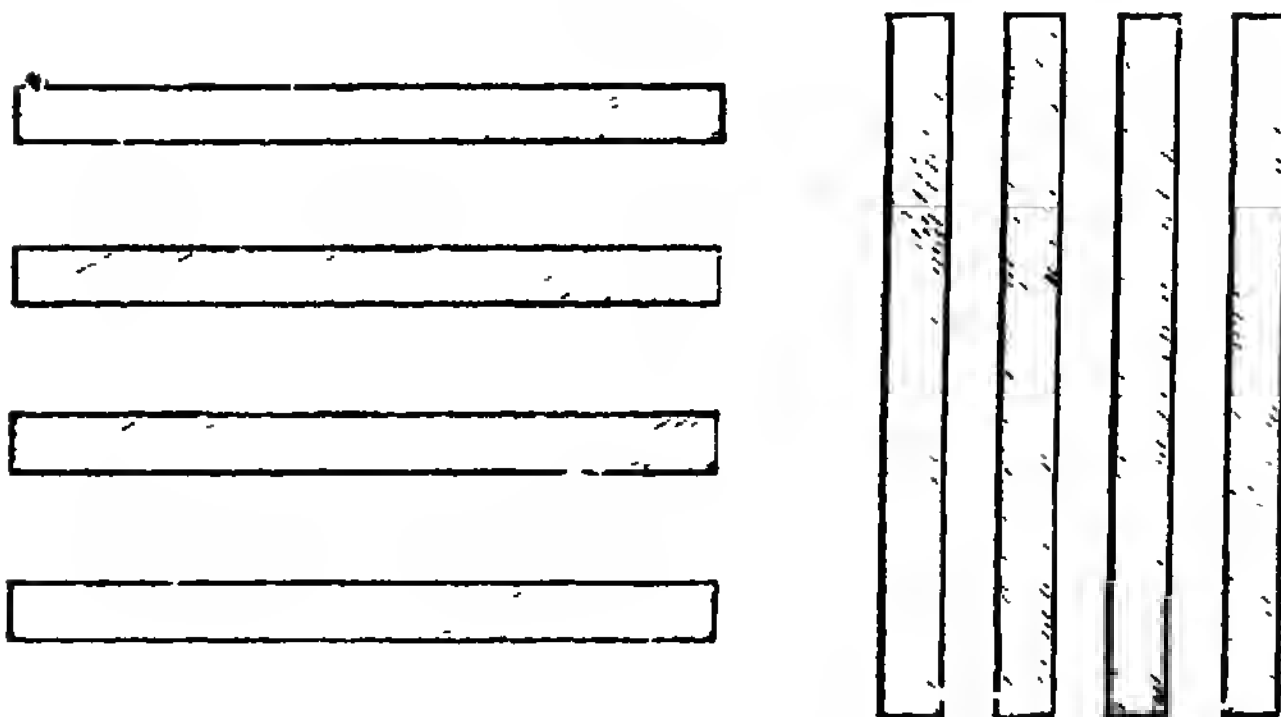
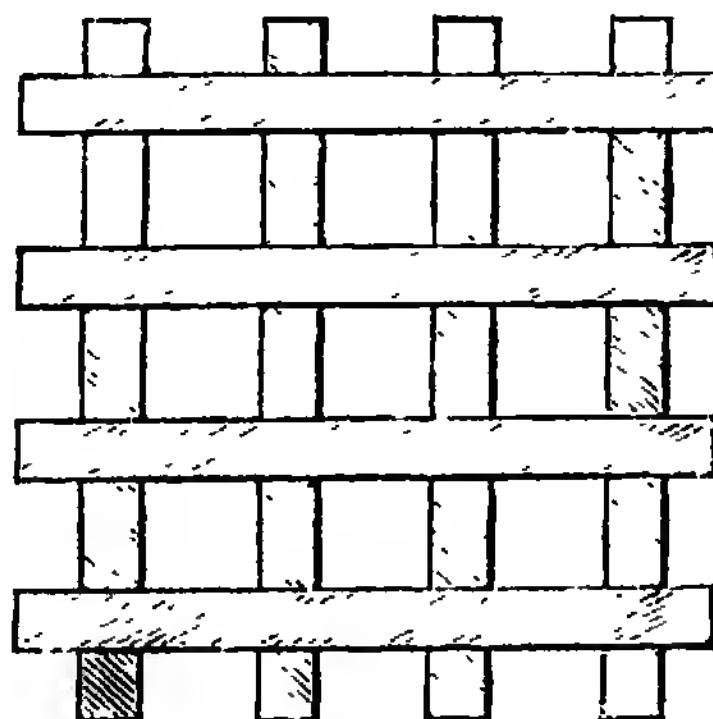


FIG. 3.



**Exercise II.****LATH AND BEAD LAYING—ANGLES.**

**MATERIALS.** —*Six wooden laths, three beads.* (See Notes A, B, p. 4.)

Lay laths parallel to each other and equidistant (Exercise I., Fig. 1).

Lay three laths end to end in a straight line.

Lay other three laths in straight line parallel to last (Fig. 1).

Lay two laths inclined to each other to form an angle, and lay a bead *in* the angle.

Lay two laths to form a right angle.

Lay another pair to form an angle less than a right angle (acute angle); and a third pair to form an angle greater than a right angle (obtuse angle).

Lay a bead in middle of angle, *i.e.* on line bisecting angle (Fig. 2).

Lay laths to form letters T, H, W, M, A, etc. (Note various angles in letters; and such facts as that upright of T is opposite middle point of cross-piece, that outer sides of M are parallel to each other, but not those of W, etc.)

FIG. 1

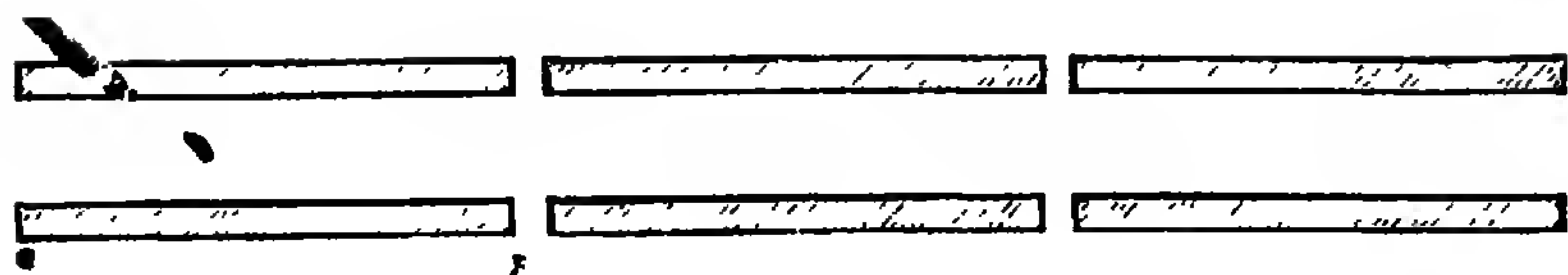


FIG. 2.

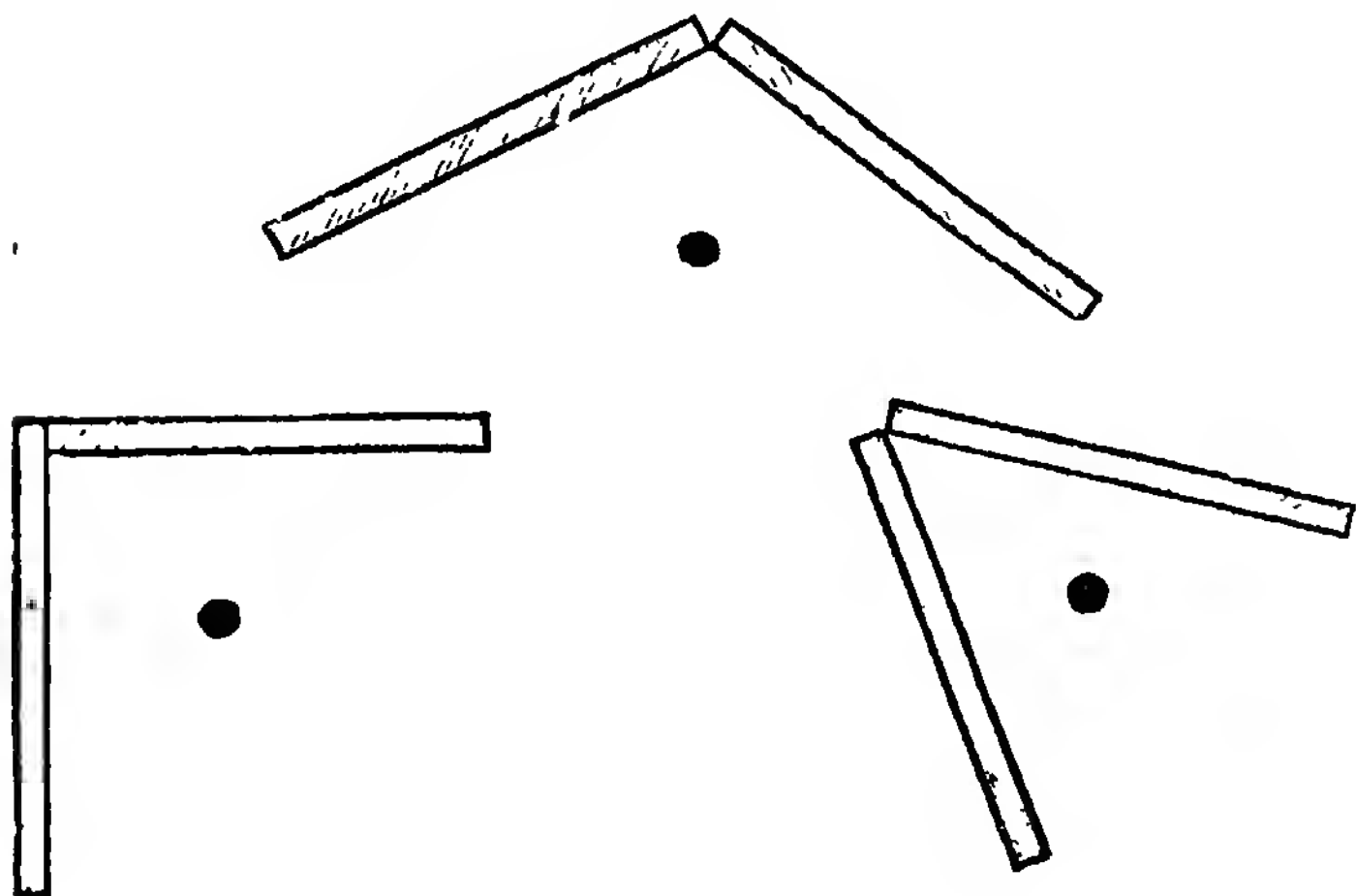
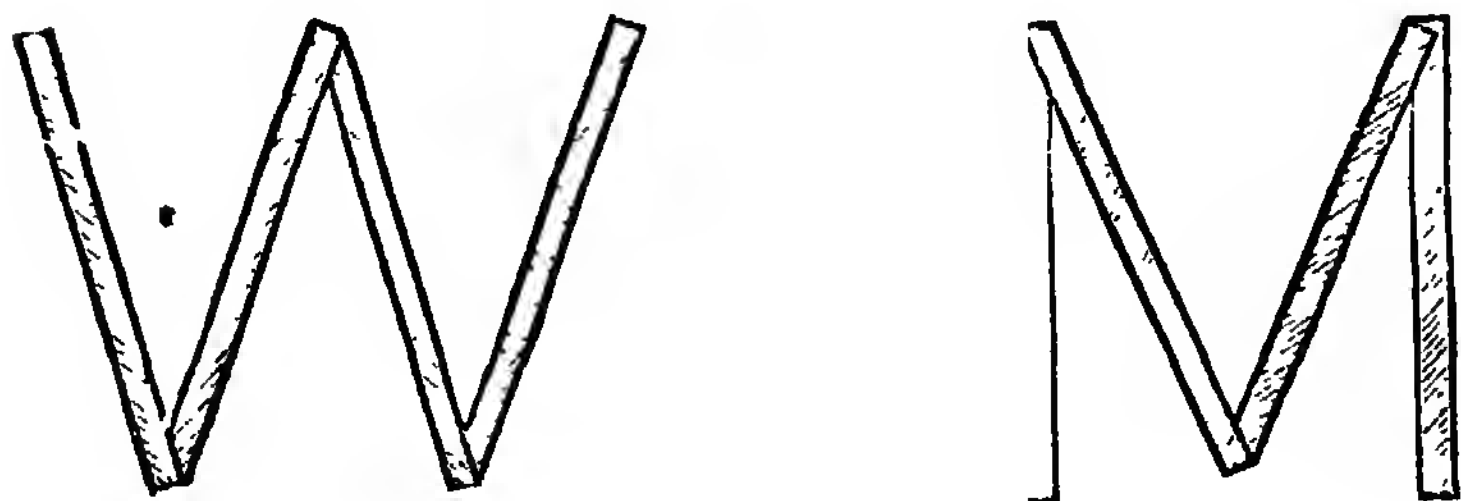


FIG. 3





**Exercise III.****PAPER FOLDING AND TEARING—SQUARE AND TRIANGLE.**

**MATERIALS.**—*Small paper square (white or coloured).* . . .

Examine paper square, and note four equal sides and four right angles.

Fold square accurately along one diagonal (Fig. 1). (Note which sides are now equal, and which angles are not right angles.)

Fold again, laying one small angle on the other (Figs. 2, 3). (Again compare sides and angles.)

Crease well, then open out the square, and note the crease lines dividing the square into four equal triangles.

Tear carefully along creases.

Lay the triangles on each other to show equality.

Lay the triangles with their four long sides in a straight line (Fig. 4).

Lay the triangles in similar positions, with four short sides in straight line (Fig. 5)

FIG. 1.

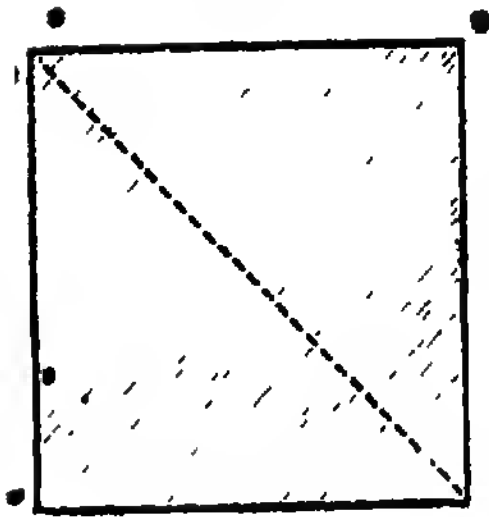


FIG. 2.

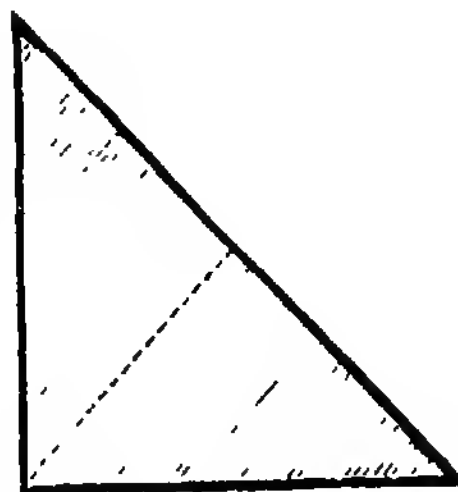


FIG. 3.



FIG. 4.

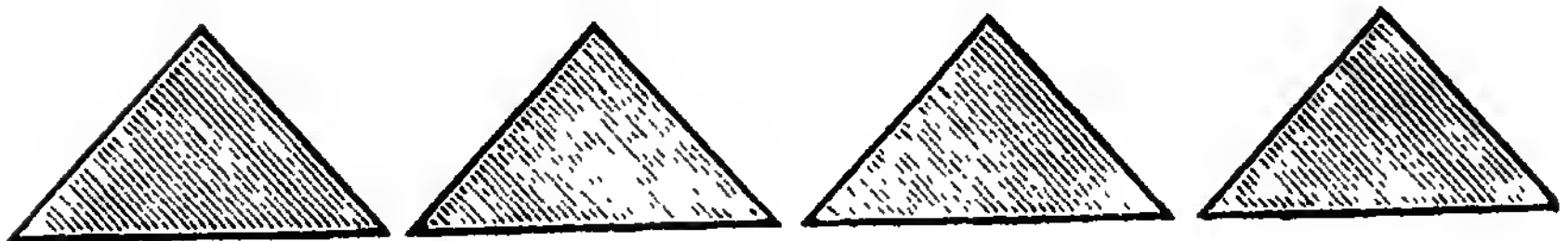
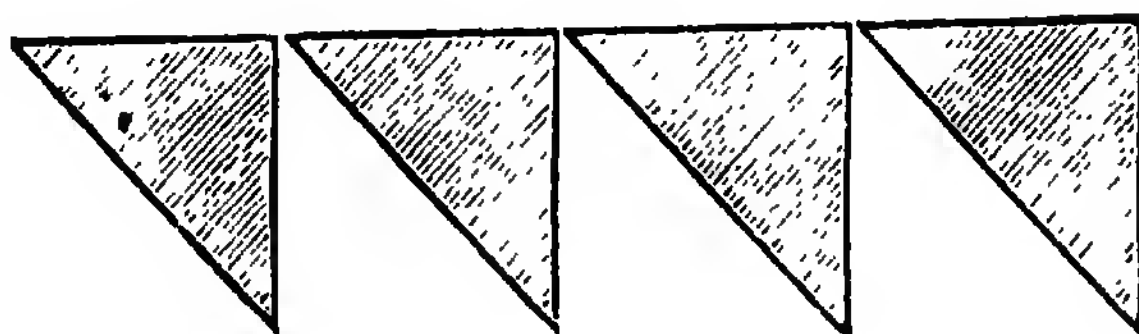


FIG. 5.



**Exercise IV.****PAPER FOLDING, CUTTING, AND LAYING**

**MATERIALS.**—*Small paper square (white or coloured).* . •

Fold square as in Exercise III. •

Crease well, open out, and slightly press out crease lines.

Cut along crease lines with scissors. (*See Note C, p. 4.*) •

Compare triangles with each other, and note that one side of each is longer than the other sides.

Lay triangles together to form original square. (Note that the long sides of the triangles form the sides of the square.)

Slightly separate the triangles to form symmetrical pattern (Fig. 1).

**NOTE.**—The latter figure might—in another lesson, if necessary—be drawn on a slate, either freehand or with ruler. Also the children might be allowed to lay another pattern of their own design, *e.g.* Figs. 2, 3, 4.

FIG. 1.

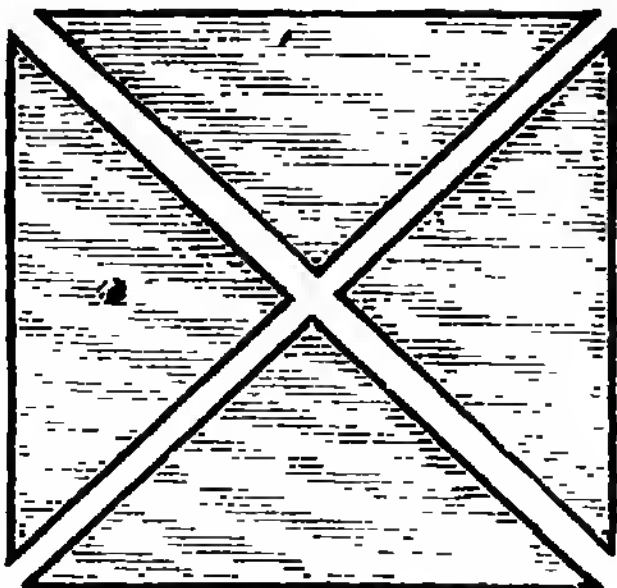


FIG. 2.

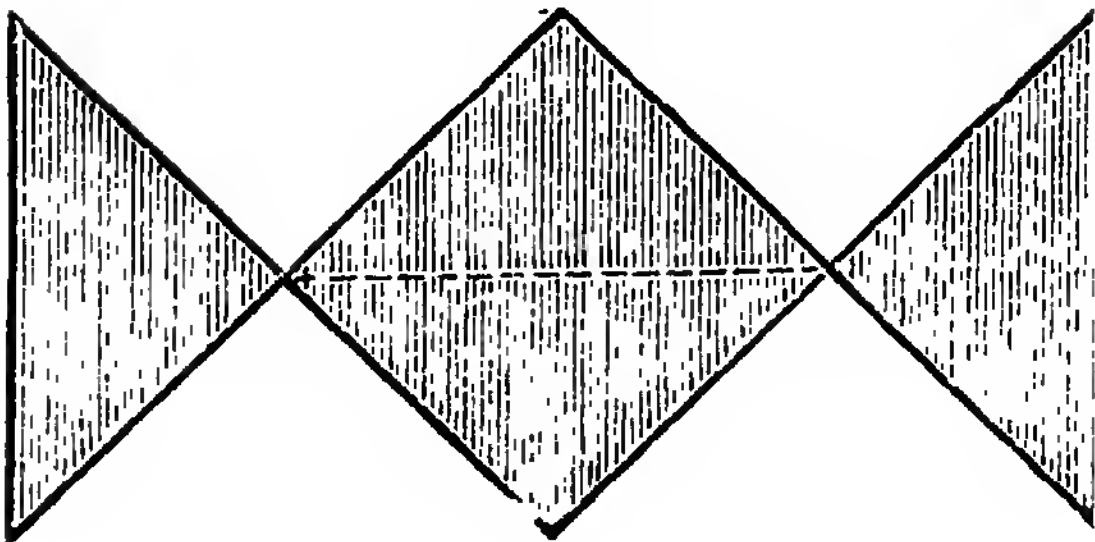


FIG. 3.

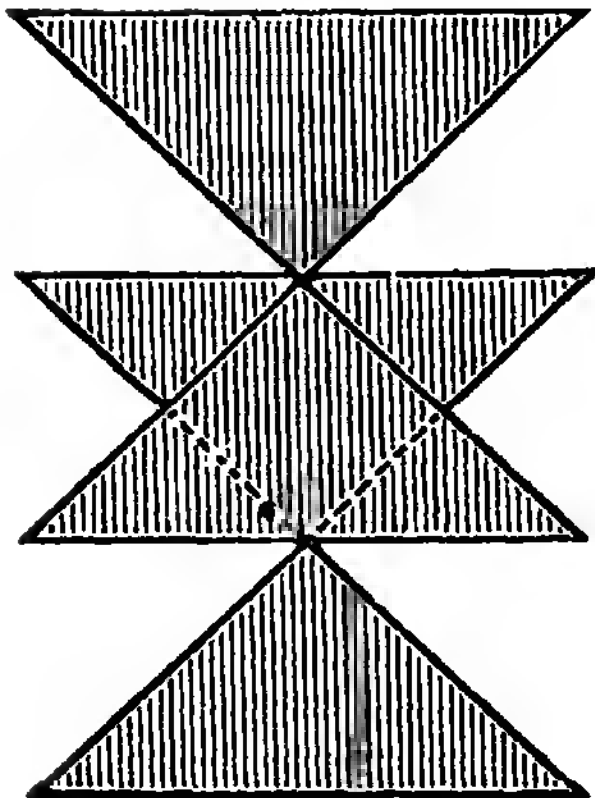
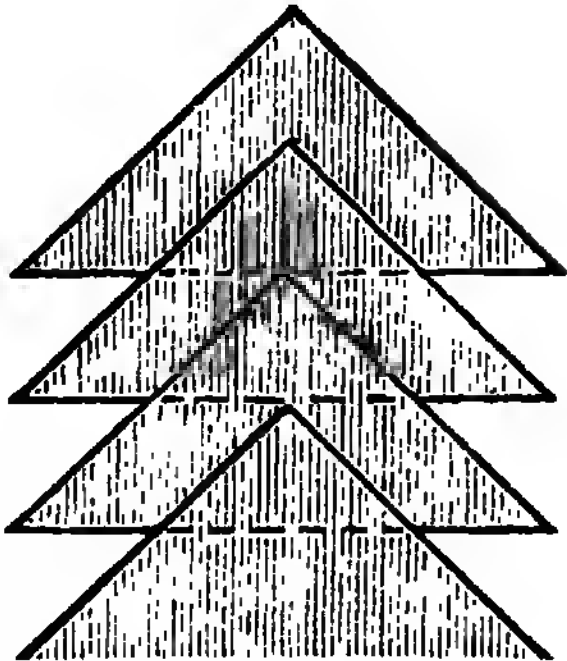


FIG. 4.



**Exercise V.****LATH LAYING—TRIANGLES.**

**MATERIALS.**—*Eight wooden laths.*

Compare the laths together (set them together with one end resting on desk) to show that all are of equal length. (Make them equal by breaking, if necessary.)

Lay four laths together to form a square.

Lay another lath along diagonal of square (Fig. 1). (Note that the diagonal is longer than a side.)

Remove two laths to leave an incomplete triangle (Fig. 2).

With three other laths form complete triangle (Fig. 3), and compare this with incomplete triangle. (Note sides of this triangle are equal; one side of other triangle, if completed, would be longer than other sides; note also that there is no right angle in complete triangle.)

Take away the laths forming the incomplete triangle, leaving the other one untouched.

Hold a lath by its estimated middle point; break there and test the two parts to see if equal.

Try to make triangle with one whole lath and the two halves. (Note, therefore, that not *any* three lines will make triangle.)

Make triangle with two whole laths and one half (Fig. 4).

Break small piece (about an inch) off one lath, and with three unequal pieces (*i.e.* a whole lath, half lath, and the lath which has had a small piece broken off) form a triangle (Fig. 5).

Mix all the laths and pieces together, and then select those required to form respectively (1) a triangle with three sides equal; (2) with only two sides equal; (3) with all sides unequal.

FIG. 1.

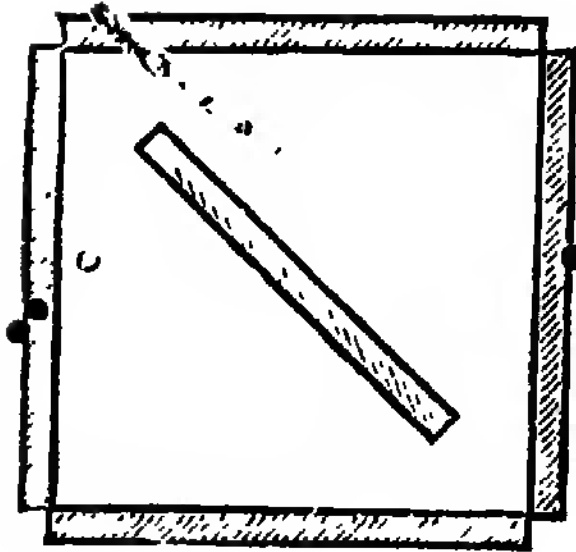


FIG. 2.

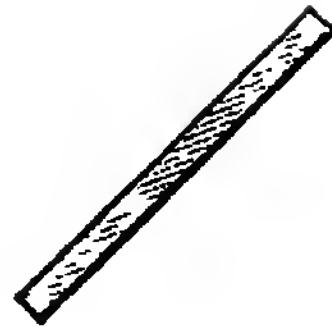


FIG. 3.

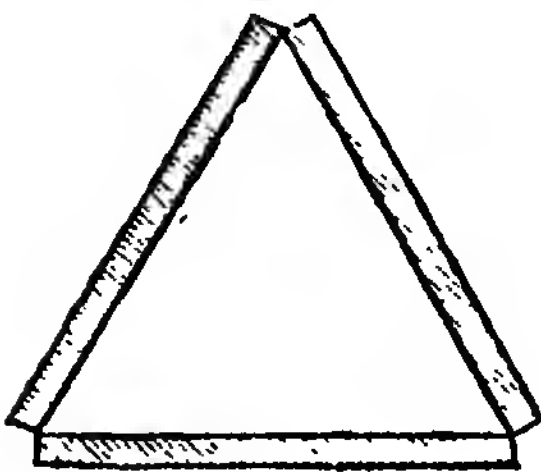


FIG. 4.

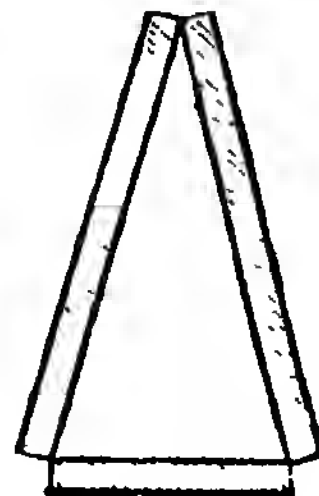
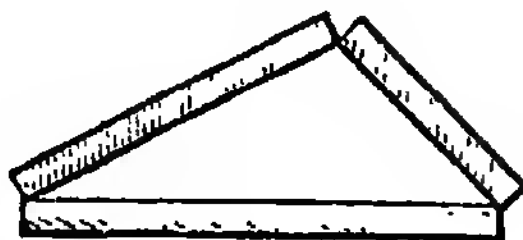


FIG. 5.



**Exercise VI.****PAPER FOLDING, CUTTING, AND LAYING—SQUARES.**

**MATERIALS.**--*Small white paper square ; metal square ; lead pencil ; scissors.*

Trace outline of model square on paper. (See that pencil is sharp, and that the point is kept close to the edge of the model in drawing the outline.)

Cut out square along ruled outline, taking care to get corners accurate.

Fold square twice at right angles to form four squares ; crease along folds, and then open out sheet (Fig. 1).

Cut carefully along crease-lines, after first partly flattening them.

Compare the four squares with each other as to size and shape.

Lay the squares at equal distances with bases in straight line (Fig. 2).

Lay the squares at equal distances with diagonals in straight line (Fig. 3).

Arrange squares to form symmetrical pattern, to design of children themselves (Figs. 4, 5, 6).

FIG. 1.

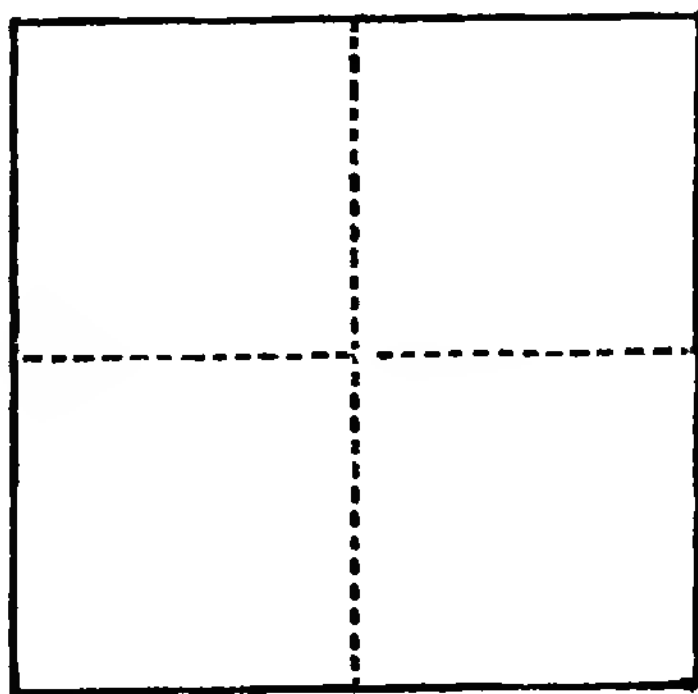


FIG. 2.

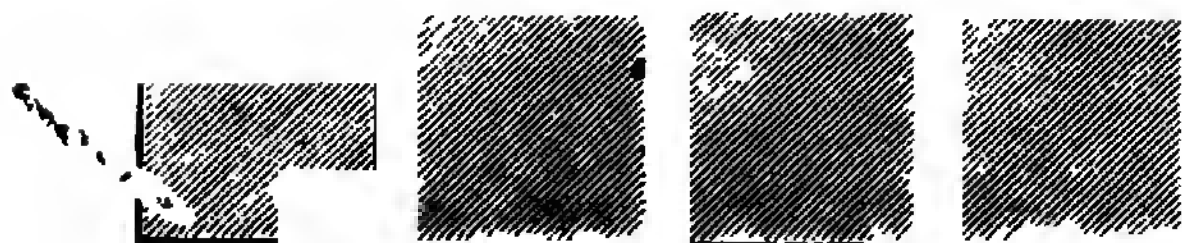


FIG. 3.

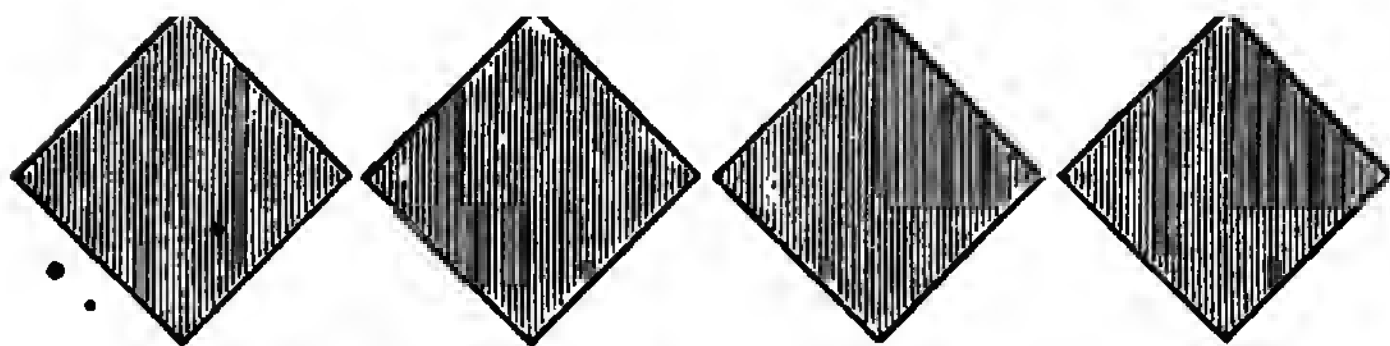


FIG. 4.

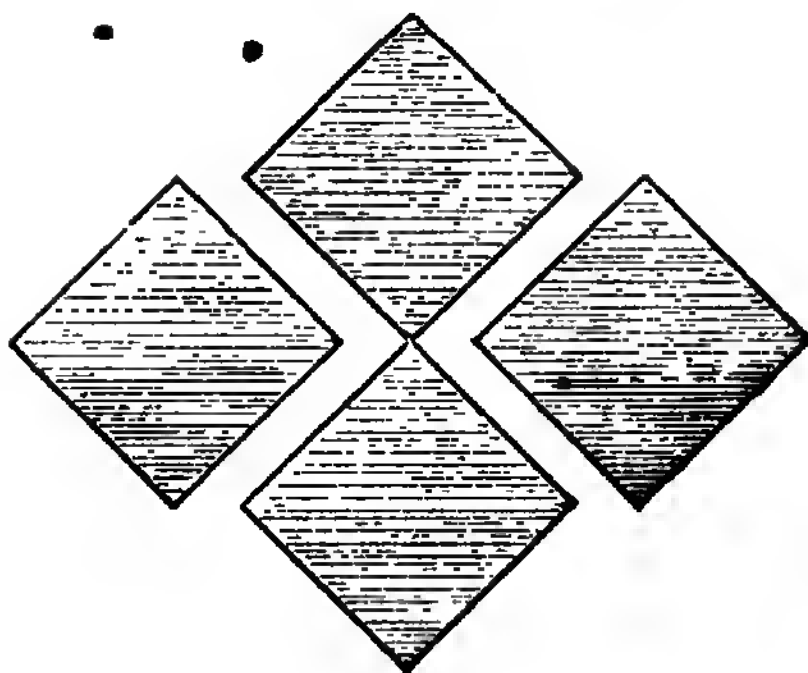


FIG. 5.

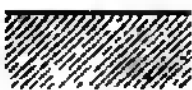
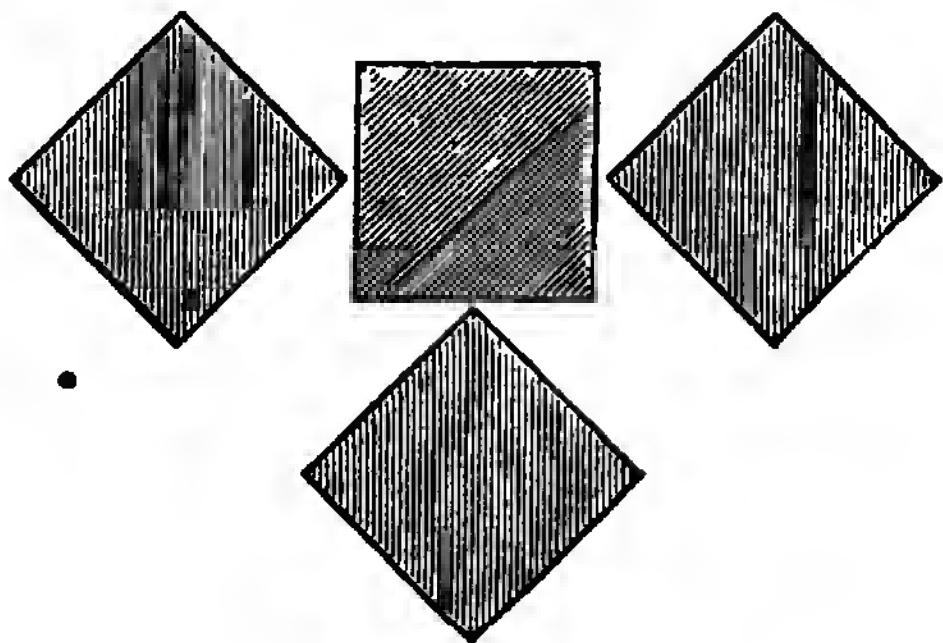


FIG. 6.





**Exercise VII.****BEAD LAYING AND PAPER CUTTING.**

**MATERIALS.**—*Small paper square ; scissors ; ruler ; lead pencil ; five beads.*

Lay bead on estimated middle point of each edge of paper square.

Lay another bead in estimated middle point of square. (Note that central line should be in line with beads on opposite sides.)

Remove beads, fold and crease square along two middle lines at right angles as in last exercise.

Open out square, flatten, and lay on desk (Fig. 1).

Lay bead as directed in middle of "upper left-hand square," etc.

Lay beads at bottom corners of square and at middle point of upper side.

Rule lines joining points last indicated (Fig. 2).

Cut out the central triangle (Fig. 3).

Lay together other two pieces to form triangle similar and equal to first (Fig. 4).

Cut off small triangle marked by crease-line across larger one.

Lay small triangle symmetrically on portion from which cut (Fig. 5). (If children use coloured paper, a child might change the small triangle with his neighbour for one of different colour.)

FIG. 1.

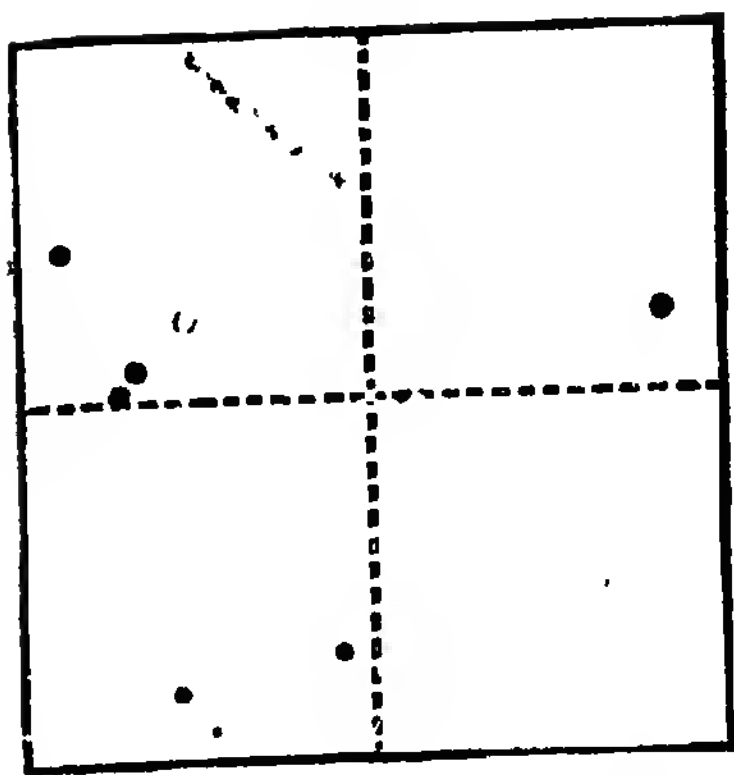


FIG. 2.

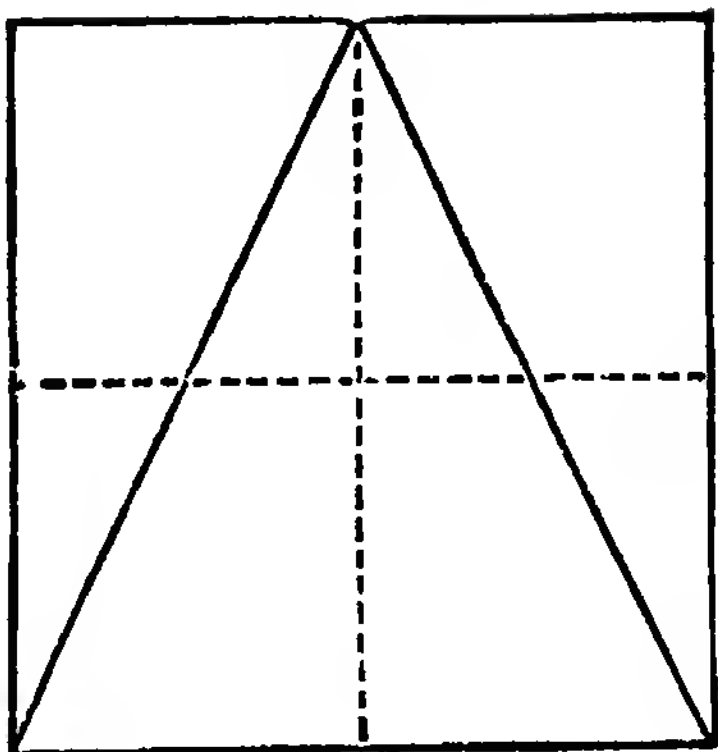


FIG. 3.

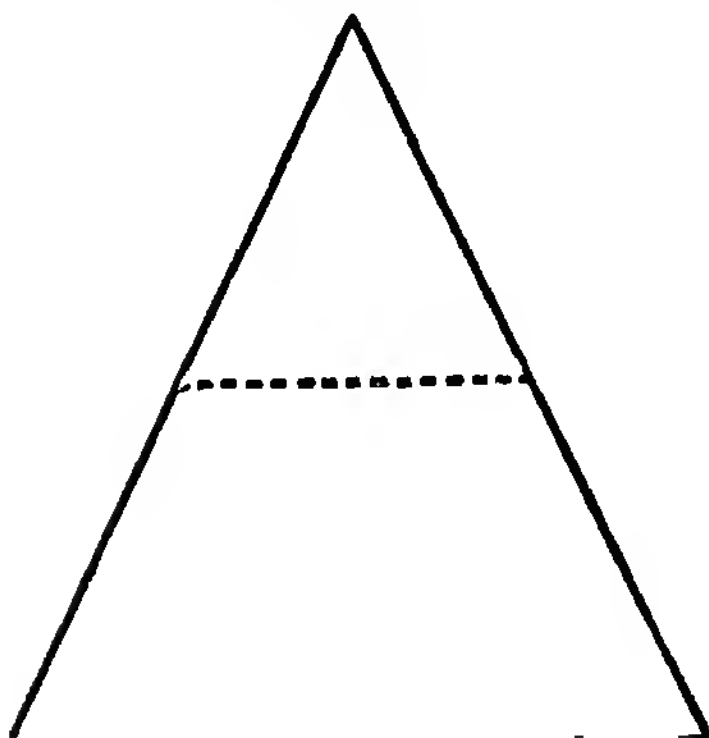
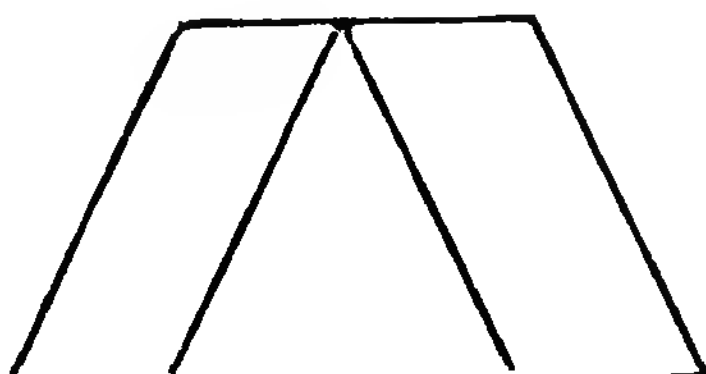


FIG. 4.

FIG. 5.



**Exercise VIII.****MEASUREMENT.**

**MATERIALS.**—*Paper strip (about 12"  $\times$   $\frac{1}{2}$ ") : foot rule ; lead pencil.*

Measure and mark point on each edge of paper distant one inch from one end.

Rule line joining the marked points and fold paper on line.

Compare this folded inch with length of finger joints, width of rule, etc.

Carefully fold whole strip in inches (folding backwards and forwards alternately); open out, and mark in numbers with pencil. (The inch marks are found by folding rather than with the rule, as an exercise in accurate folding.)

Mark in points indicating half-inches by help of rule.

Measure with strip (and also with rule) length of fingers, sides of book or slate, width of desk, circumference of wrist, etc. (Note advantage of using strip that will bend in measuring round wrist, etc.)

## **Exercise IX.**

### **STRING MEASUREMENT AND DIVISION.**

**MATERIALS.**—*Piece of string over 12" long; rule; scissors.*

Cut piece of string to exact length of twelve inches by the rule.

Lay out string on desk and place finger on estimated middle point.

Take up string by estimated middle point, and double it to test if correct.

Crease string at true middle point (found by doubling), measure each half with the rule, and tie knot at centre.

Similarly find middle point of each half, first estimating it, then measuring and tying 'not.

Fold string into three equal parts; cut there, and measure each part. (If the string is rather thick, the knots will take off appreciably from the length of each piece as calculated.)

Unravel one piece of string (if not too thin and tightly twisted) to show its component fibres.

**Exercise X.****CLAY MODELLING BALL, CYLINDER, AND DISC.**

**MATERIALS.**—*Moist clay (sufficient to make ball 1½ to 2 inches diameter); modelling board; damp sponge. [Large sphere and cylinder, as used for model drawing, in front of class.]*

Roll the clay (*see Note G, p. 6*) on modelling board, or between the hands, to form well-shaped ball or sphere (Fig. 1). (Lay the clay sphere on the board, and show that it rolls readily in any direction.)

Roll out clay on board to form cylinder; flatten the ends and set cylinder to stand vertically (Fig. 2).

Flatten the clay to form an approximately circular disc (Fig. 3). (Compare with coin or metal disc used in exercises.)

[If there is time, when the exercise is well done, let children model clay into form of any object they choose.]

FIG. 1.

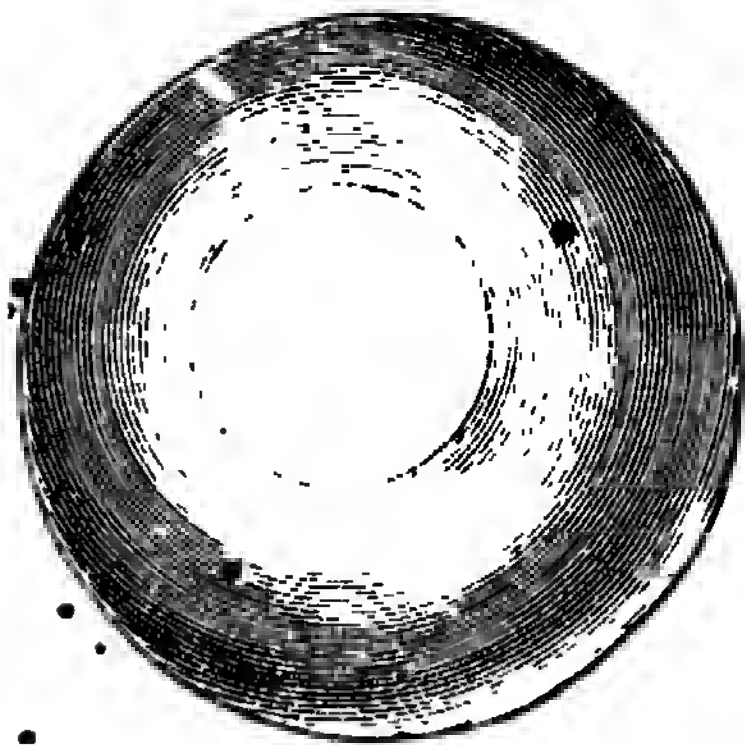


FIG. 2.

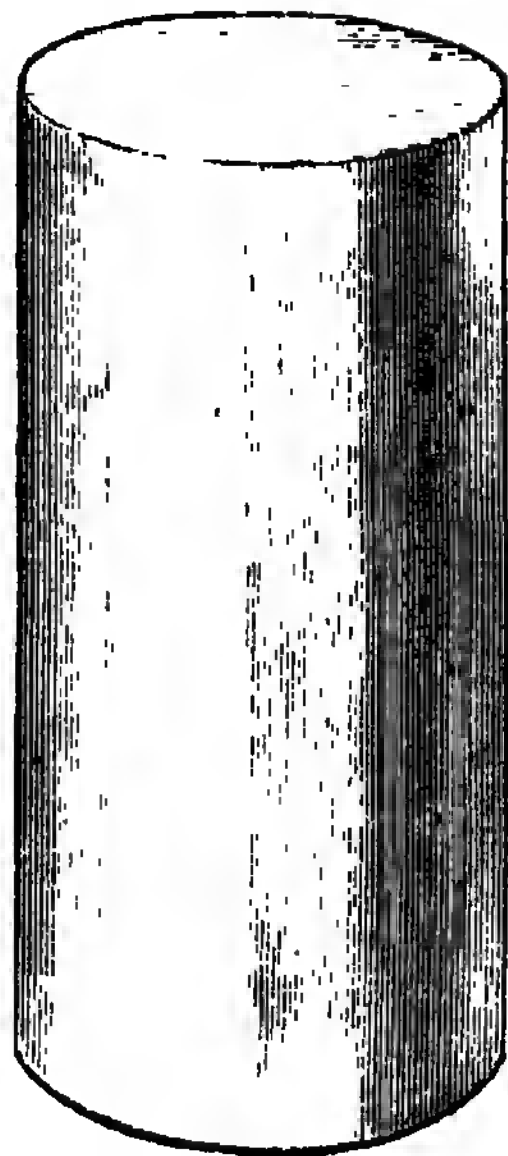
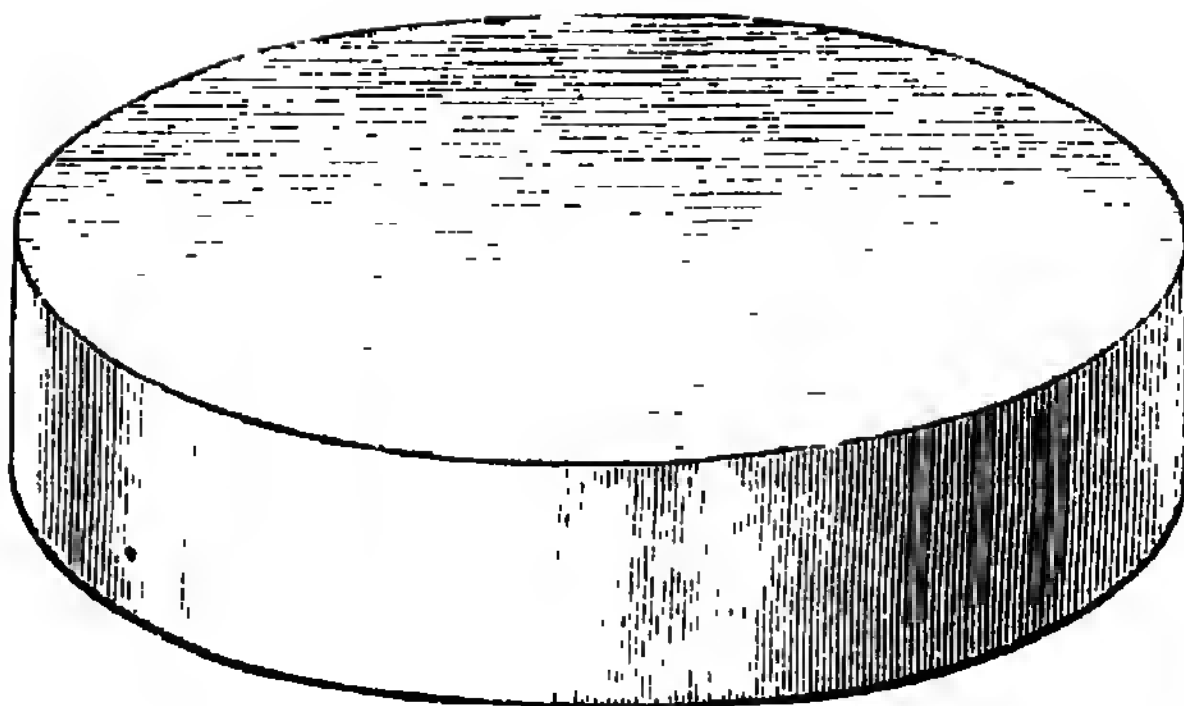


FIG. 3.



**Exercise XI.**

## CLAY MODELLING — BOWL.

**MATERIALS.**— *Moist clay ; modelling board ; thin string (about six inches long) for cutting clay ; damp sponge. [As a model use an orange cut in two ; one half having the pulp carefully removed, leaving the peel unbroken.]*

•

Roll the clay into a sphere (Fig. 1).

Cut sphere with thin string into two hemispheres. (Compare the hemispheres with each other and with original sphere.)

Lay one hemisphere on its flat face, other on its curved part (Figs. 2, 3). (Note how easily latter rocks from side to side, while former stands steadily.)

Model one hemisphere into a hemispherical bowl, similar to peel of half-orange (Fig. 4).

[If there is time, attach simple handle to bowl, first wetting points of contact, and with remainder of clay let children model any object they choose.]

FIG. 1.

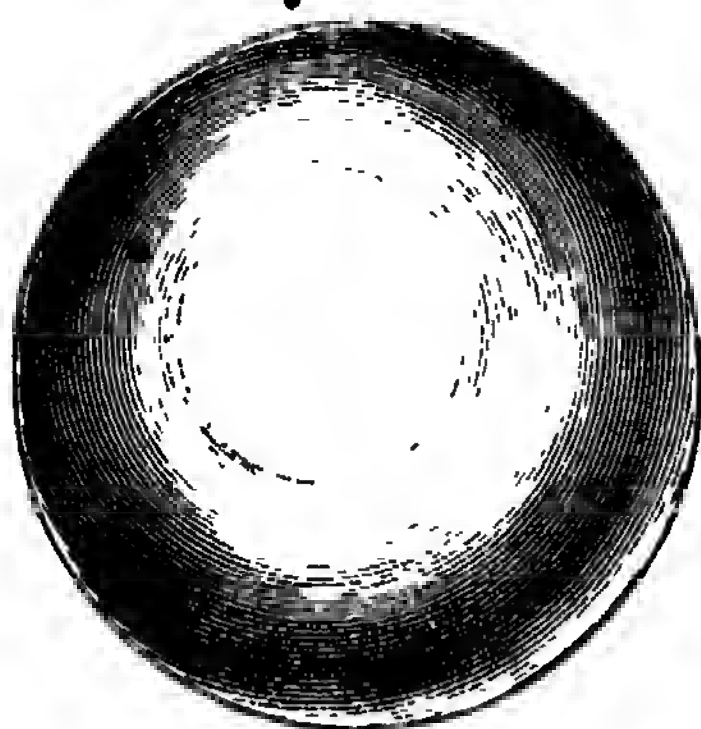


FIG. 2.



FIG. 3.



FIG. 4.





**Exercise XII.****CLAY MODELLING—REPETITION.**

**MATERIALS.**—*Moist clay ; modelling board ; thin string for cutting clay ; damp sponge.*

Roll clay into sphere.

Cut sphere with string into two hemispheres.

Cut each hemisphere into two equal parts.

Roll each of four pieces into small sphere and lay together to compare sizes.

Retain one piece in form of sphere, make second into cylinder, third into bowl, and fourth into object chosen by child himself. (Note that there is an equal quantity of clay used for each object.)



**Exercise XIII.****PAPER CUTTING AND BEAD LAYING—CIRCLE.**

**MATERIALS.**—*Small white paper square ; scissors ; nine beads ; model circular disc (metal) ; lead pencil ; rule.*

- Lay circular disc symmetrically in middle of paper square.
- Outline circle on paper. (See that point of pencil is kept close to model.)
- Cut carefully along the outlined circle.
- Lay paper circle on desk. (Note that it looks the same in all positions on desk, having no corners.)
- Lay bead in estimated centre of circle.
- Lay four beads on circumference at opposite points, and note if all are at same distance from central bead (Fig. 1).
- Lay other four beads on circumference half-way between first four.
- Take up beads from circumference, and lay row of five across circle as a diameter (Fig. 2). (Note two semicircles.)
- Lay other four to form diameter at right angles to first (Fig. 3). (Note four quarter-circles and four right angles.)
- Fold circle along several diameters and crease.
- Open out creased circle and measure with the rule the various diameters creased to show all equal (Fig. 4).

FIG. 1

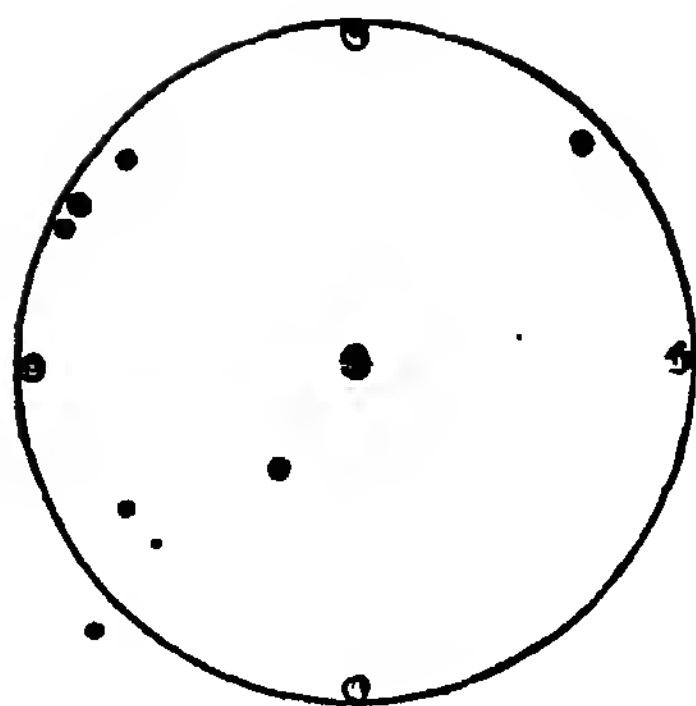


FIG. 2.

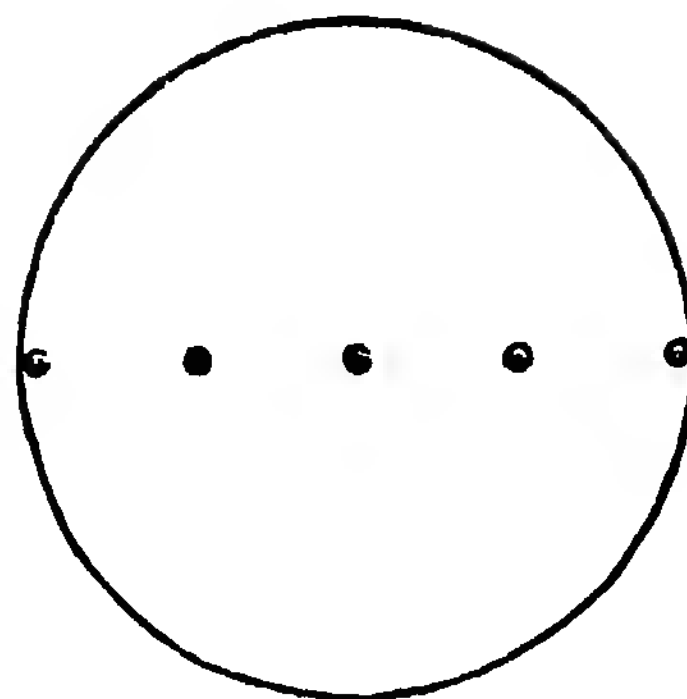


FIG. 3.

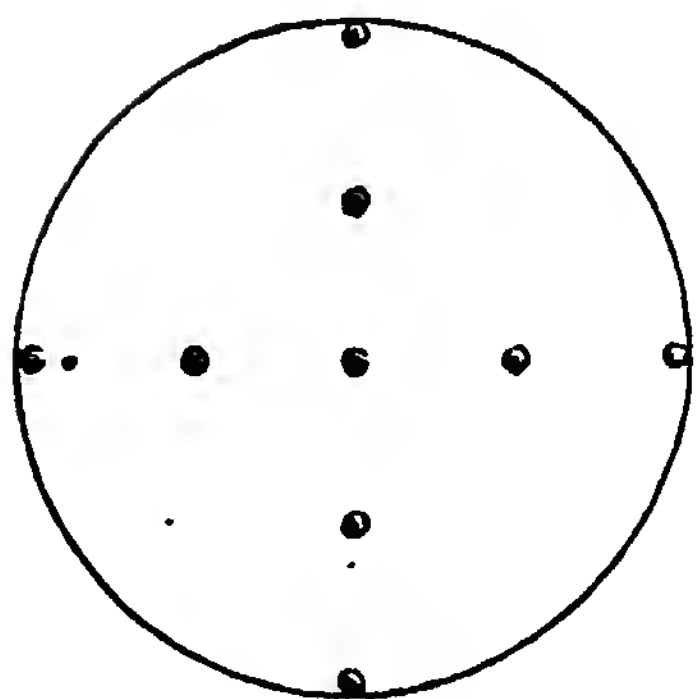
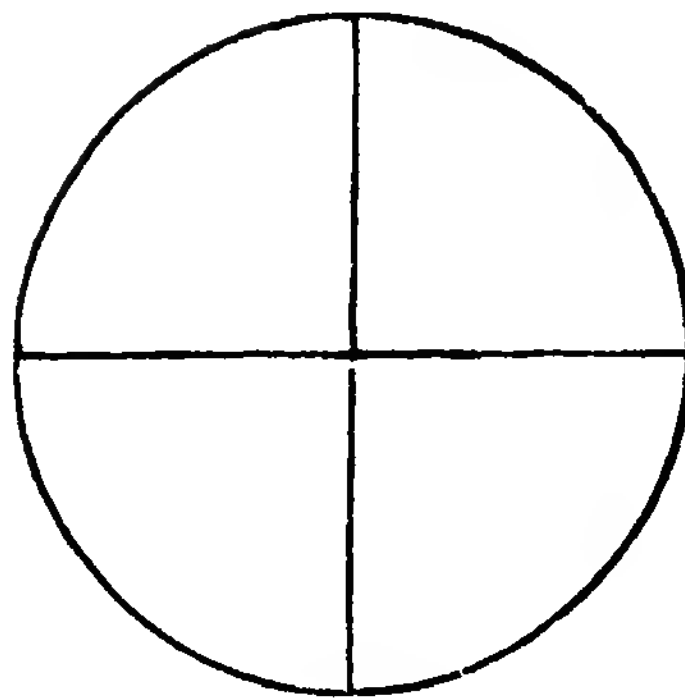


FIG. 4.



**Exercise XIV.****LATH AND BEAD LAYING—CIRCLE.**

**MATERIALS.**—*Four laths ; rule ; lead pencil ; eight beads ; slate and pencil.*

Measure the laths to see if all of equal length, and make equal if necessary.

Find middle point of each lath and mark with pencil.

Lay two laths crossing at middle points at right angles (Fig. 1).

Lay other two laths to bisect angles between first two, and crossing at their middle points (Fig. 2). (Note that from central point portions of equal length project in various directions.)

Lay beads in spaces between ends of laths to outline a circle (Fig. 2).

Break one lath at middle point and use as ruler.

From central point on slate rule lines in various directions, equal in length to half-lath.

Fill up spaces between ends of lines with dots to outline circle (Fig. 3).

FIG. 1.

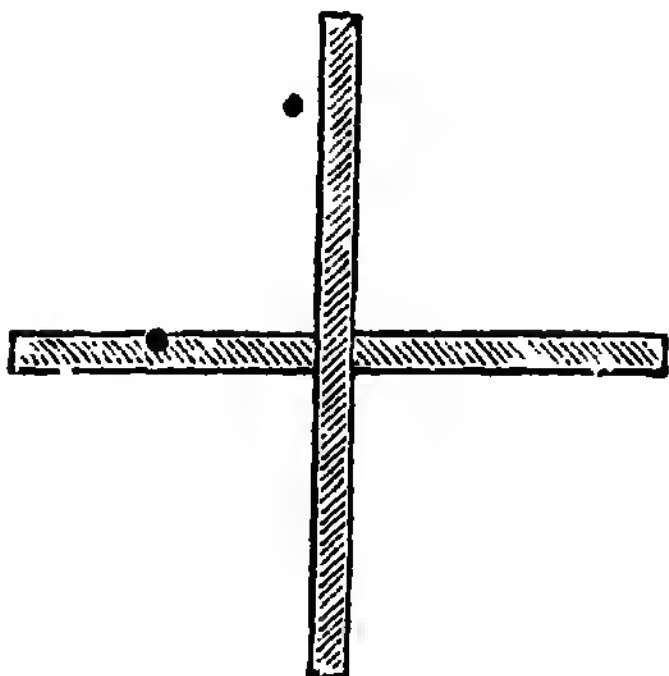


FIG. 2.

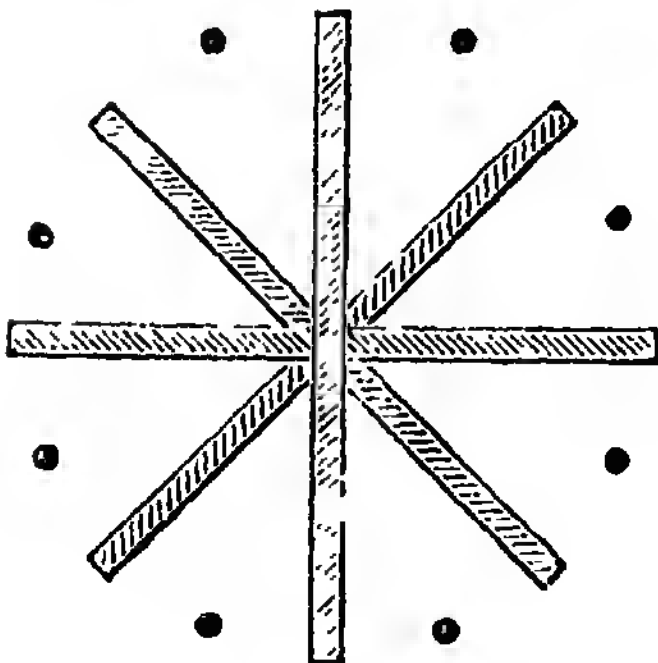
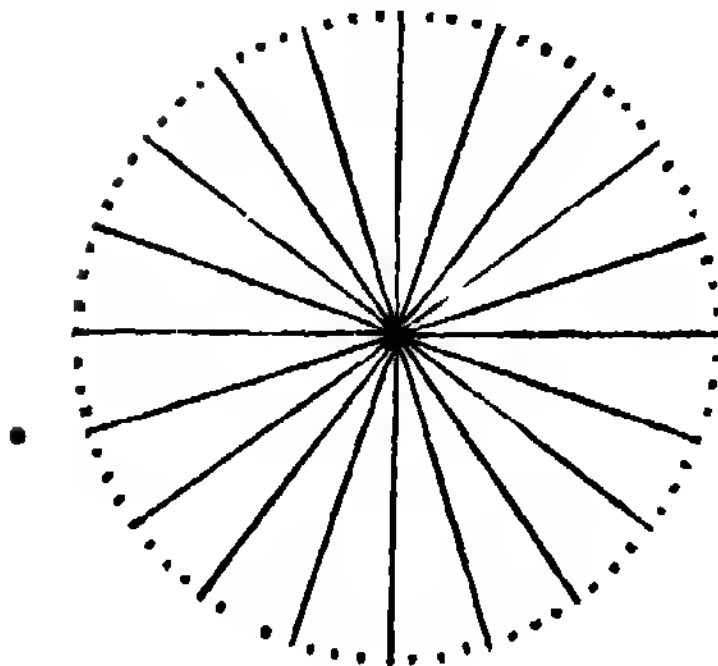


FIG. 3.



**Exercise XV.****LATH AND RING LAYING—CARDINAL POINTS.**

**MATERIALS.**—*Two laths ; five rings ; slate and pencil ; ruler.*

Lay two laths crossing at estimated middle points at right angles (without measurement).

Lay ring symmetrically at point where laths cross (see figure).

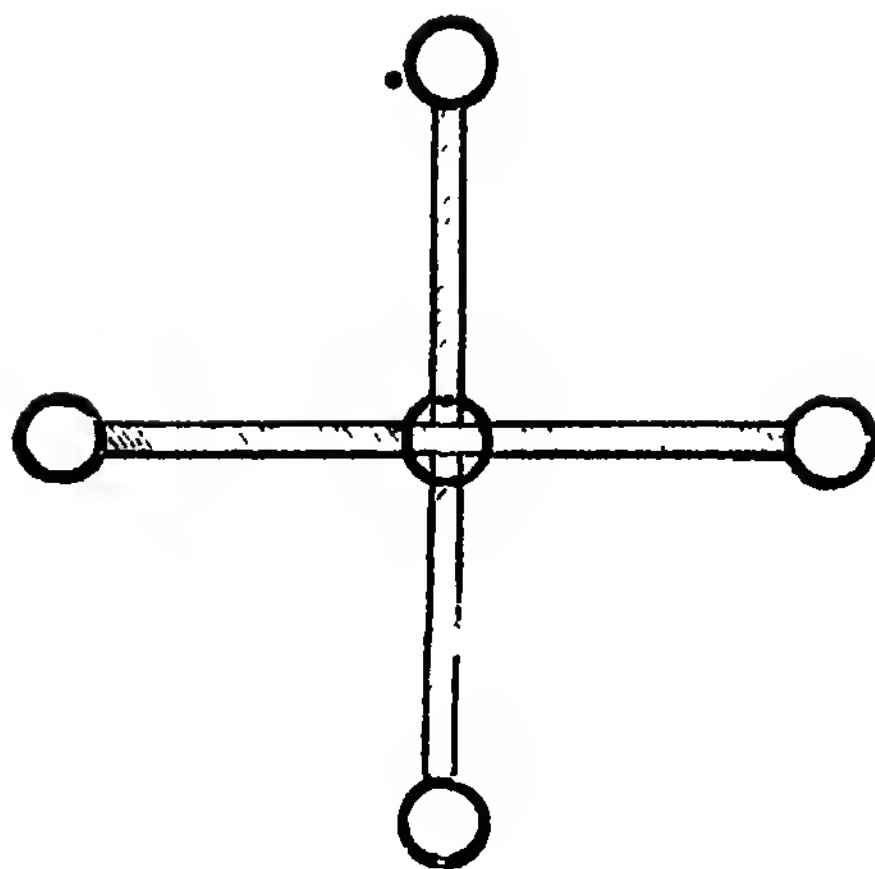
Lay ring symmetrically at ends of each lath.

Draw figure similar, and of same size, on slates, ruling the lines and using a ring to trace the circles.

Print letters N, S, E, W inside circles of drawing.

Draw same figure freehand.

**NOTE.**—Many other exercises in laying laths, beads, and rings, besides those described in the exercises, will readily suggest themselves ; e.g. with laths and beads laying a semicircle, laying a square with beads, etc.





**Exercise XVI.****RING LAYING.**

MATERIALS.—*Slate and pencil, rule; six rings.*

Rule straight line across slate near the top.

Lay six rings touching each other and touching the line.

Mark dot (or small cross) with pencil at estimated centre of each ring (Fig. 1).

Remove rings and note that dots are at equal distances from each other and from line.

Rule second line and place six dots, without measurement, as nearly as possible in similar position to the others (Fig. 2).

Test positions of estimated points by laying rings.

Rule third line on slate, and place six dots in position by measurement, and again lay rings.

Rule line lengthwise on slate and lay rings in pairs on either side of line, touching each other (Fig. 3).

Mark dots in centre of rings, and remove rings.

As before, rule lines and place dots in similar positions, first without, then with, measurement.

FIG. 1.

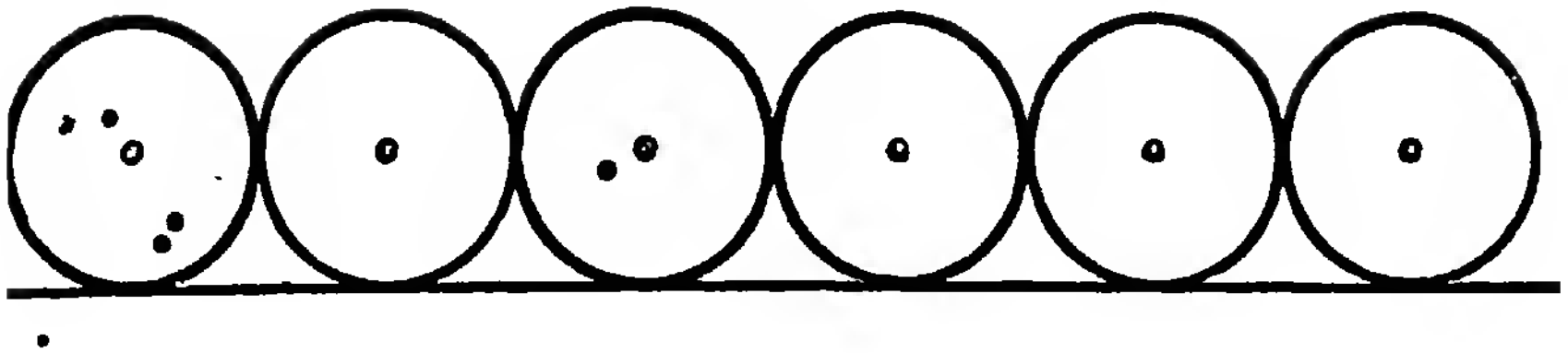


FIG. 2.

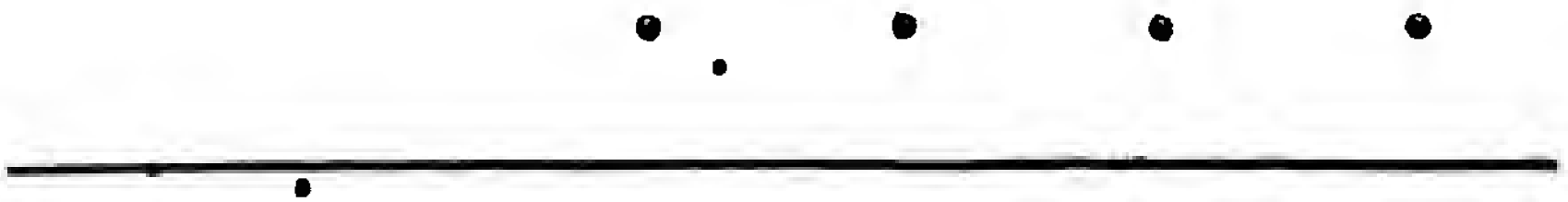
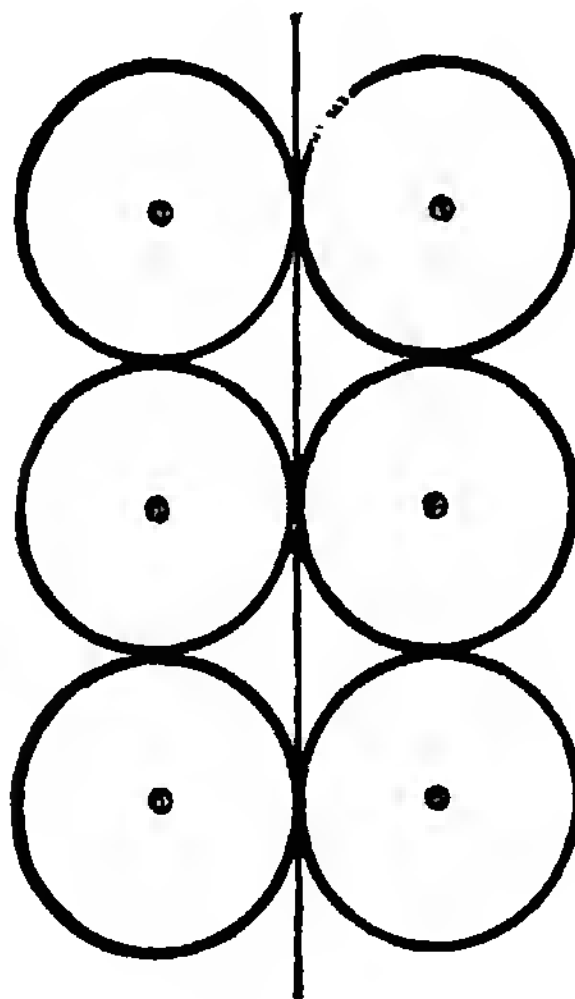


FIG. 3.



**Exercise XVII.****CLAY MODELLING—SPHERE AND CUBE.**

**MATERIALS.**—*Moist clay ; modelling board ; two flat (square) pieces of wood ; damp sponge. [Large cube as model.]*

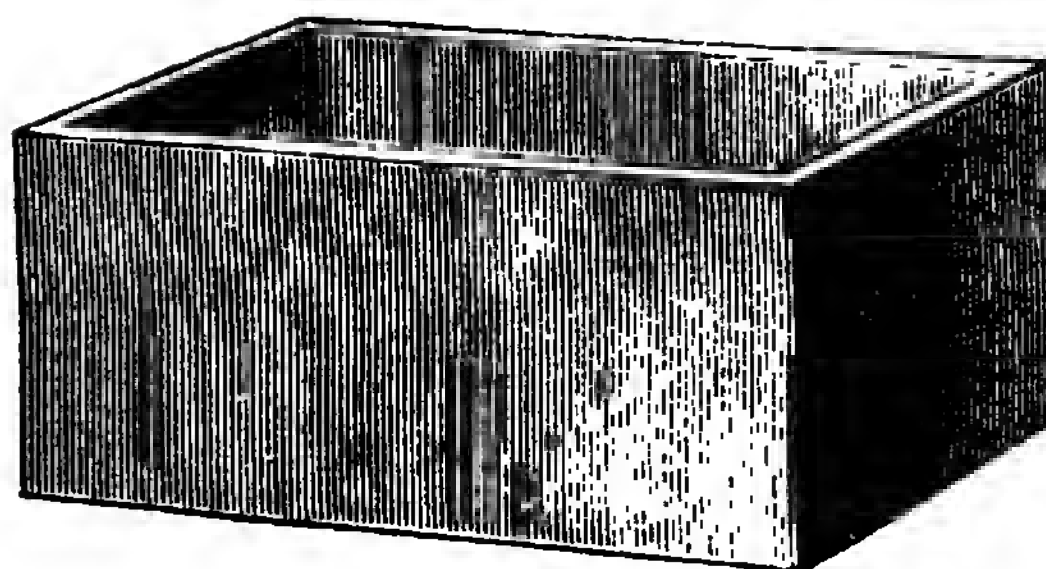
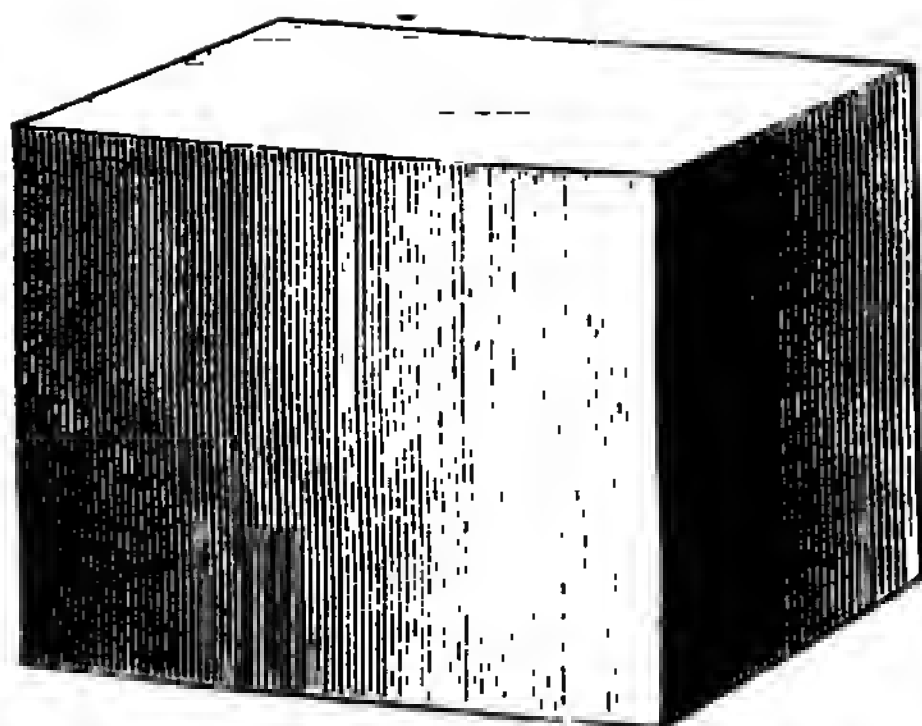
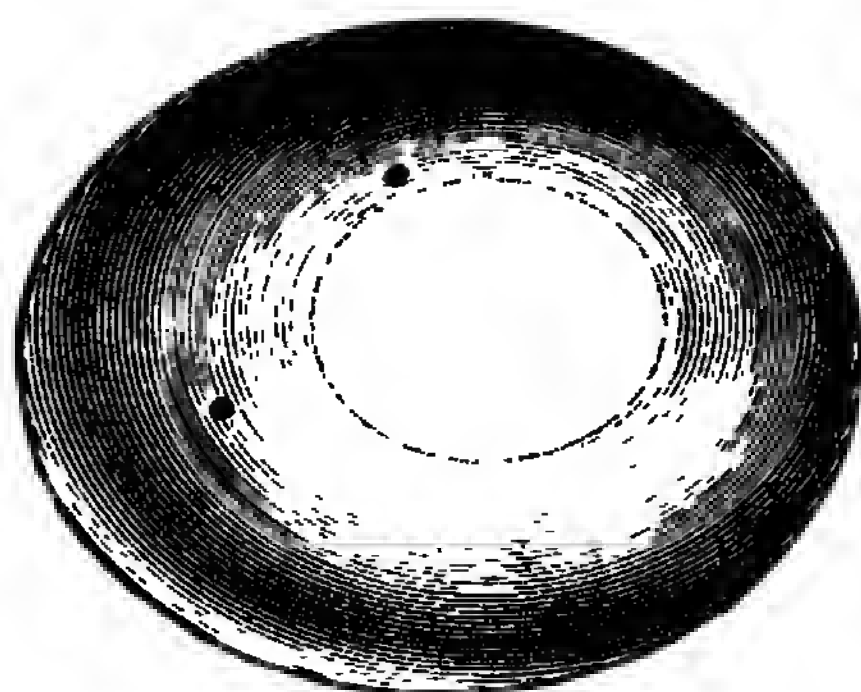
Roll clay into sphere.

Gently press and knock clay sphere on modelling board, to produce flat faces similar to those of cube.

Use flat wooden blocks held parallel (one in each hand) to press clay into form of cube. (Show that there are three pairs of parallel faces on the cube used as a model.)

Make edges and corners of cube as sharp as possible by use of blocks.

Model clay with fingers to form as well as possible a hollow box.



**Exercise XVIII.****CLAY MODELLING—DIVISIONS OF SPHERE.**

**MATERIALS.**—*Moist clay ; modelling board ; thin string for cutting clay ; slate and pencil ; damp sponge. [Large apple or orange of regular shape as a model.]*

Roll clay into sphere.

Cut clay sphere, by thin string, into two hemispheres.

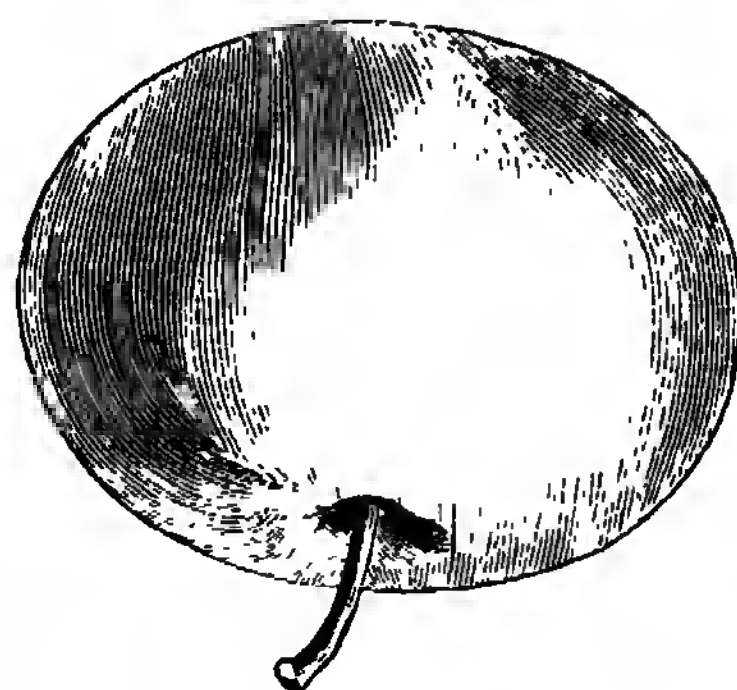
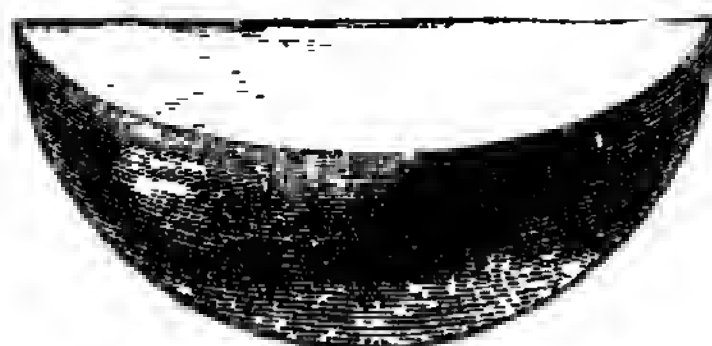
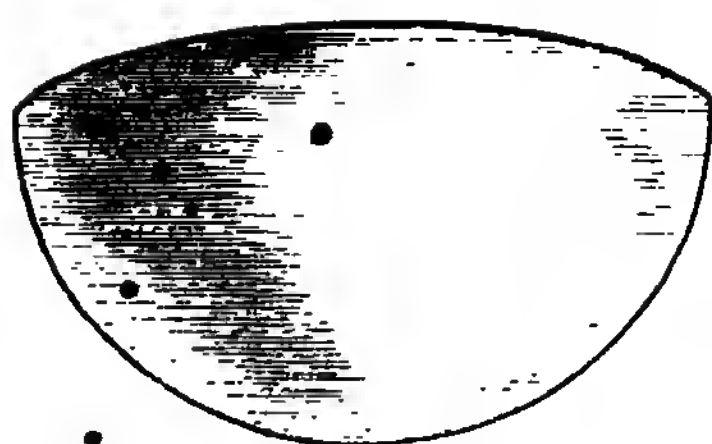
Lay one hemisphere on its flat face on the slate, and trace its circular outline.

Cut other hemisphere into two equal parts with string.

Lay one quarter so produced on one of its flat faces, and trace outline ; then do the same with the other face.

Make up clay again into one piece (moistening the faces of the pieces if necessary).

Make model of apple or orange. (First direct attention to manner in which the fruit differs from a perfect sphere.)



**Exercise XIX.****PARALLEL RULING—SIMILAR FIGURES**

**MATERIALS.**—*Small white paper square ; slate and pencil ; ruler ; scissors.*

Lay square symmetrically in middle of slate.

Rule lines parallel to edges of square, and distant about half an inch.

Rule second series of lines outside and parallel to first, and at similar distance (Fig. 1).

Remove paper square, note that lines drawn form two squares, then replace paper square in former position.

Mark position of corners of paper square carefully with pencil.

Remove paper square and rule lines joining marked points.

(Note that, if all accurately drawn, the diagonals of all three squares are in same straight line.)

Fold square along one diagonal, crease there, and cut.

Lay one triangle so formed symmetrically in centre of slate.

Rule two series of lines parallel to and at equal distances from the central triangle, as was done in the case of the square (Fig. 2).

Remove the paper triangle, examine drawings, and then replace paper in former position.

Mark corners of paper triangle, remove and rule lines joining points.

[If there were time, one of these sets of lines might be drawn freehand.]

FIG. 1.

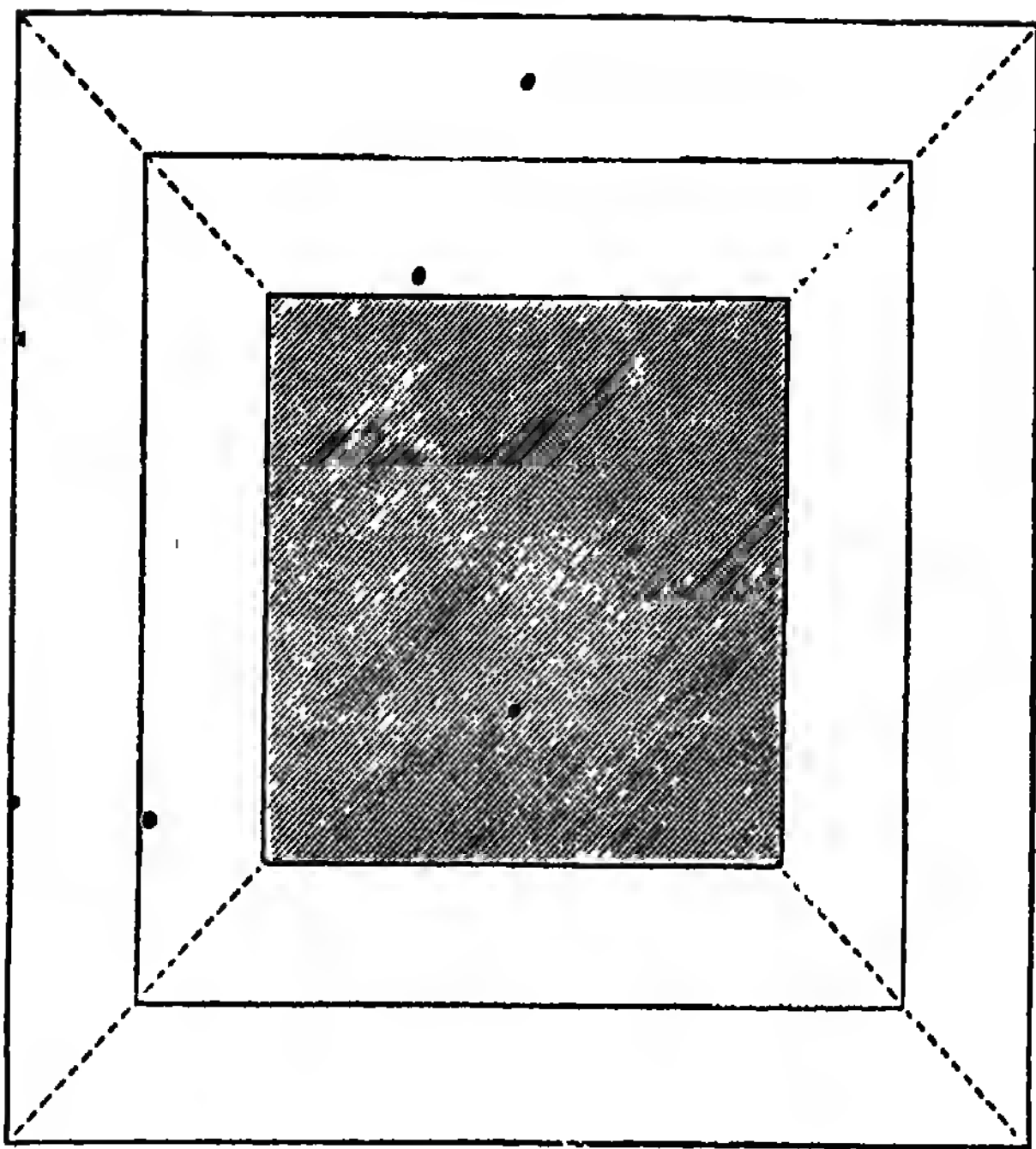
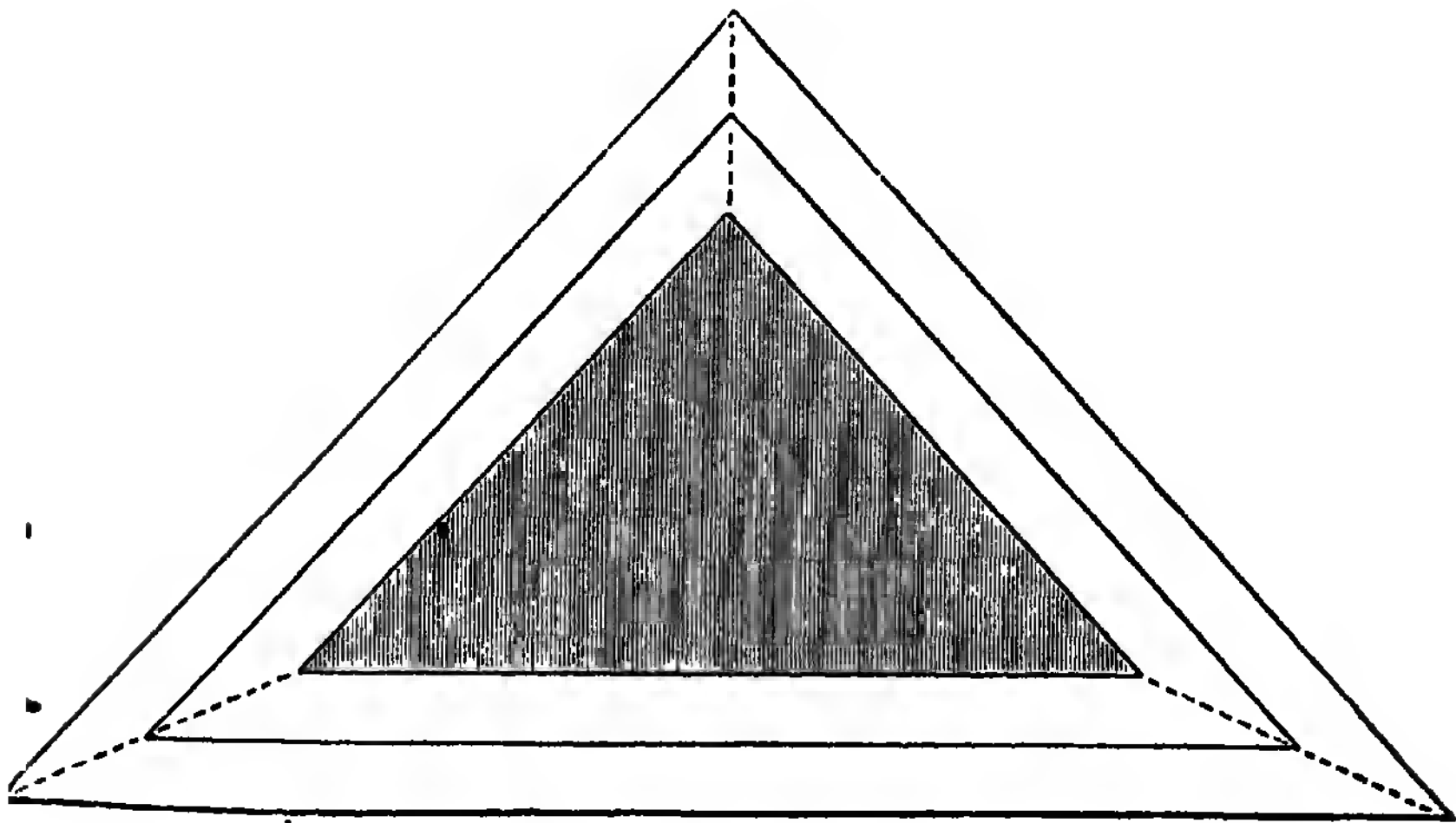


FIG. 2.





**Exercise XX.****COLOUR SORTING.**

**MATERIALS.**—*Series of pieces of coloured wool in bag (see Note E, p. 5) ; large white pater square to lay wools on. [Teacher's corresponding set of coloured skeins.]*

Select from bag piece of wool of same colour and shade as specimen skein shown. (Use a very distinct colour at first. Lay the specimen by the side of the piece selected by the child, and ask him to say whether they are exactly alike.)

Repeat with several other colours in succession.

Pick out from the full series of wools all the pieces which could be called red, blue, yellow, etc.

Select from the reds or blues the very light and the very dark ones, and arrange the series in order of shade.

Lay together, or twist loosely together, two pieces selected by teacher which go well together.

Similarly put together two pieces which do not harmonize well. Let child select a piece similar to specimen shown, and then himself find a second colour to go well with first.

**NOTE.**—This exercise might with advantage be repeated several times at intervals.



**Exercise XXI.****PAPER CUTTING AND MOUNTING (PLATE 1.).**

**MATERIALS.**—*Large white paper square ; two differently coloured, gummed paper squares (to look well together) ; scissors ; lead pencil ; rule ; damp sponge.*

Lay one coloured square partly over the other on the white square to see whether the colours look well together.

Rule faintly the diagonals of the white paper square.

Lay one coloured square symmetrically in middle of white square. (Note that its corners will be on the diagonals and its sides parallel to those of larger square.)

Moisten the gum and fasten down coloured square in position.  
(*See Note D, p. 4.*)

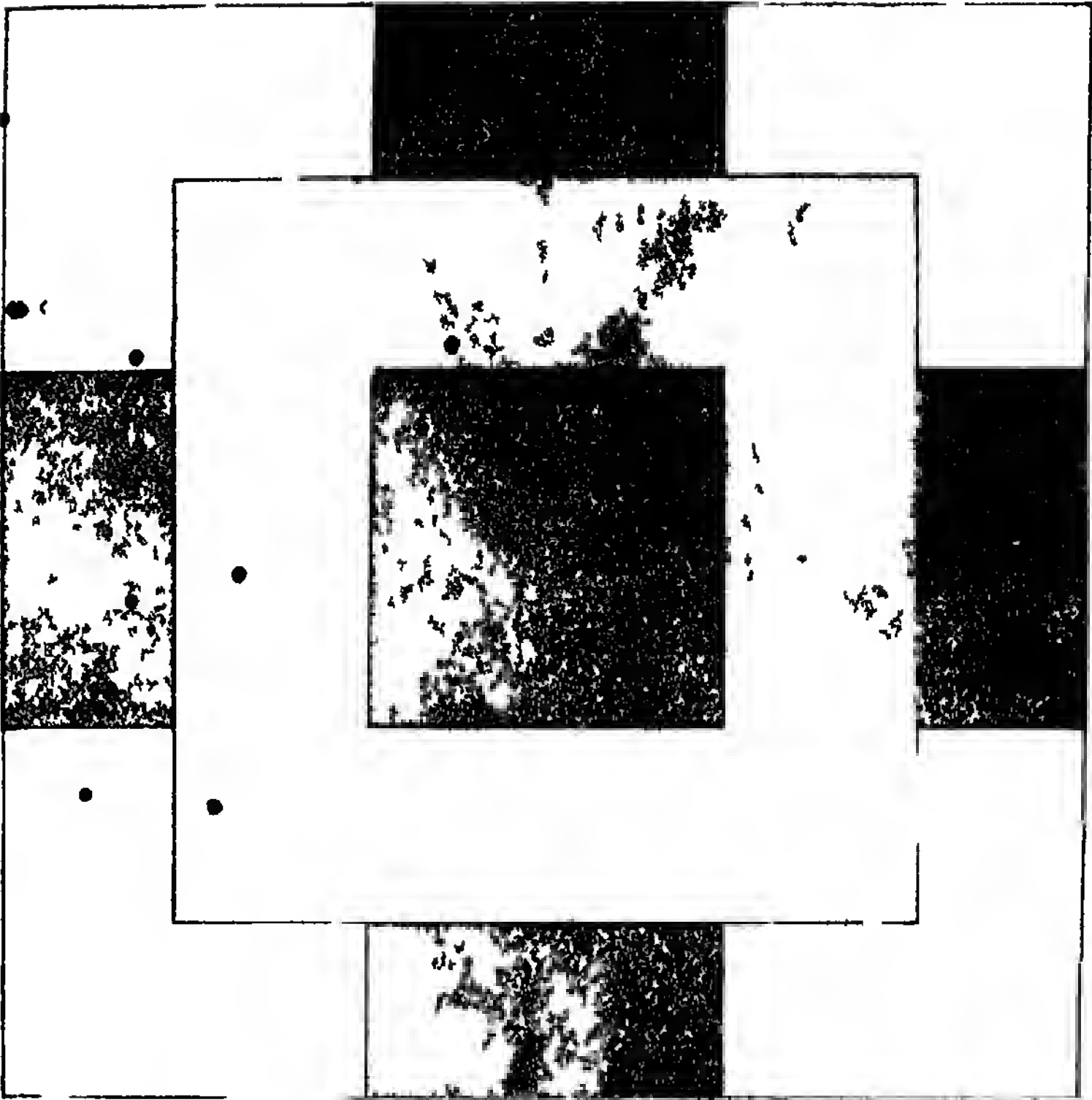
Mark points on other coloured square (on gummed side, if the other does not show pencil marks well), at distance of one inch from each corner, and rule lines joining marked points.

Cut along the ruled lines to leave central square. (The measuring, ruling, and cutting must be very carefully done, as also the mounting, since the finished exercise will test the accuracy of the work.)

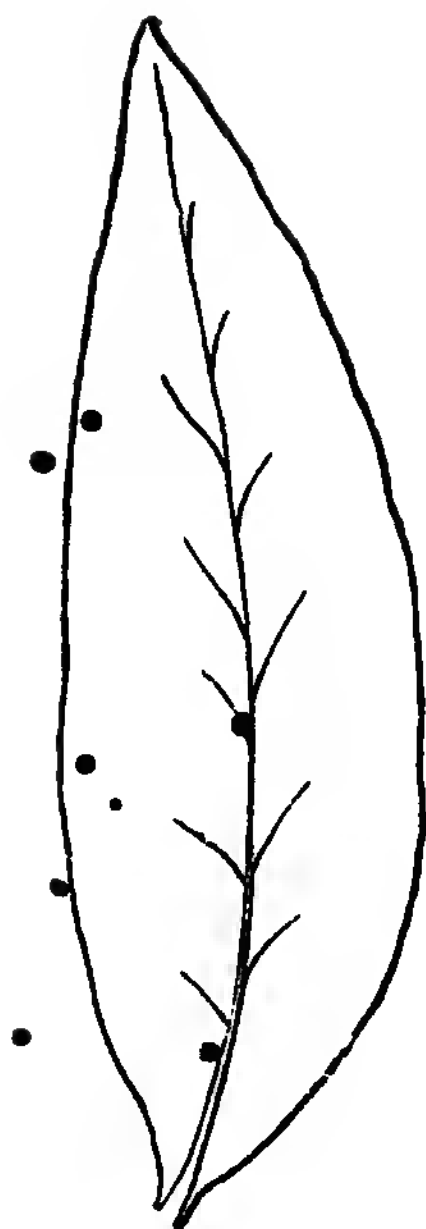
Lay small coloured square just cut in centre of, and with sides parallel to, mounted square. (This may be tested by laying the rule along the diagonals of the three squares, which should all coincide.)

Moisten gum and fasten down small square.

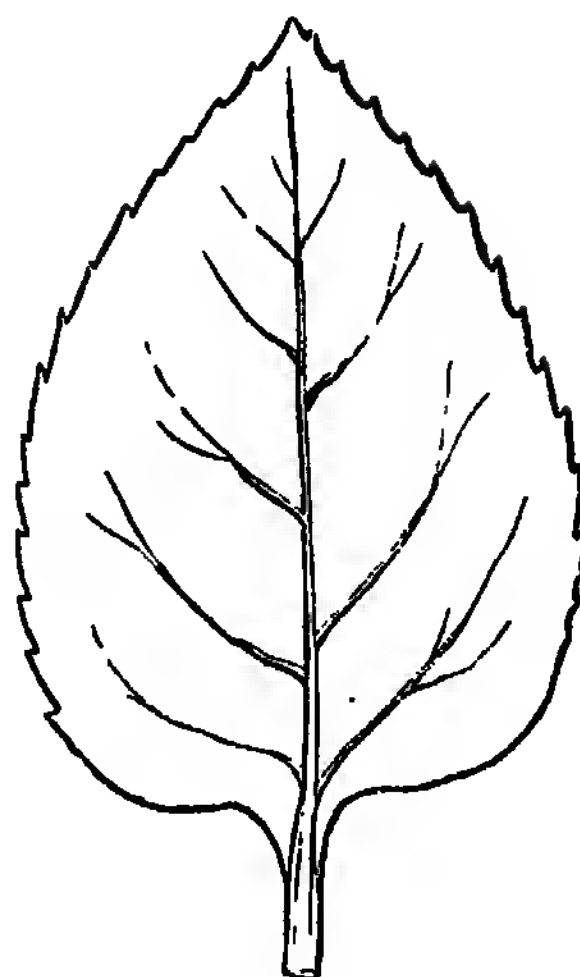
Cut from the coloured strips left from second coloured square pieces having length equal to side of central square, and mount as in Fig. 1, Plate II.



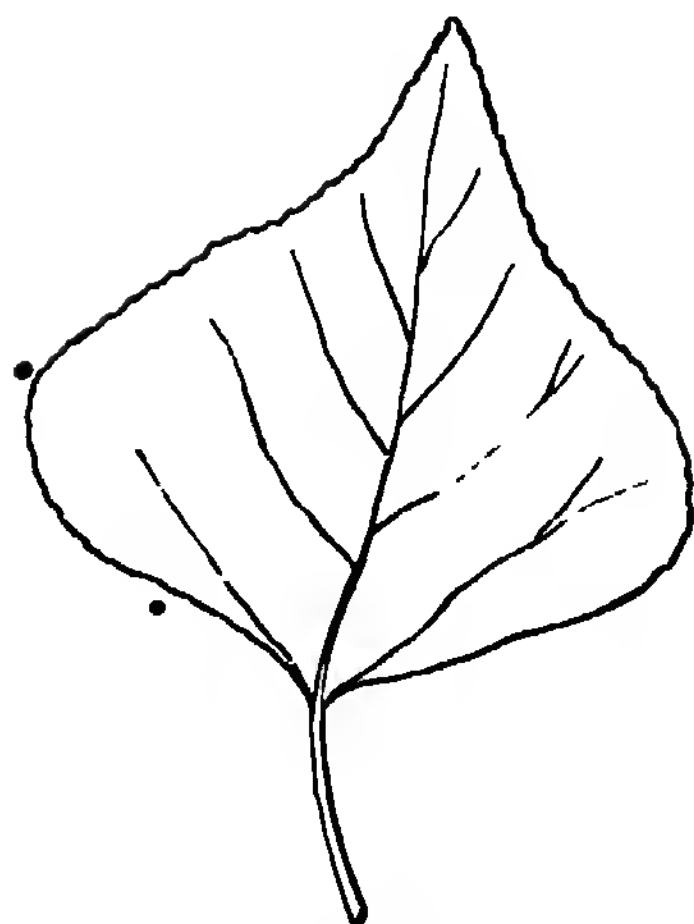




LAUREL.



FUCHSIA.



LILAC.



POPLAR.

(See Exercise XIII.)

**Exercise XXII.****DRAWING ON SQUARED PAPER.**

**MATERIALS.**—*Squared paper : lead pencil : scissors. [Copy of leaf outline]*

[NOTE.—The squares on the paper used by the children should be quarter inches, but the teacher could get squared cardboard with inch squares on which to draw copies to be placed in front of the class. Some dried and pressed leaves of fairly large size and simple shape would be useful in this and some of the following exercises.]

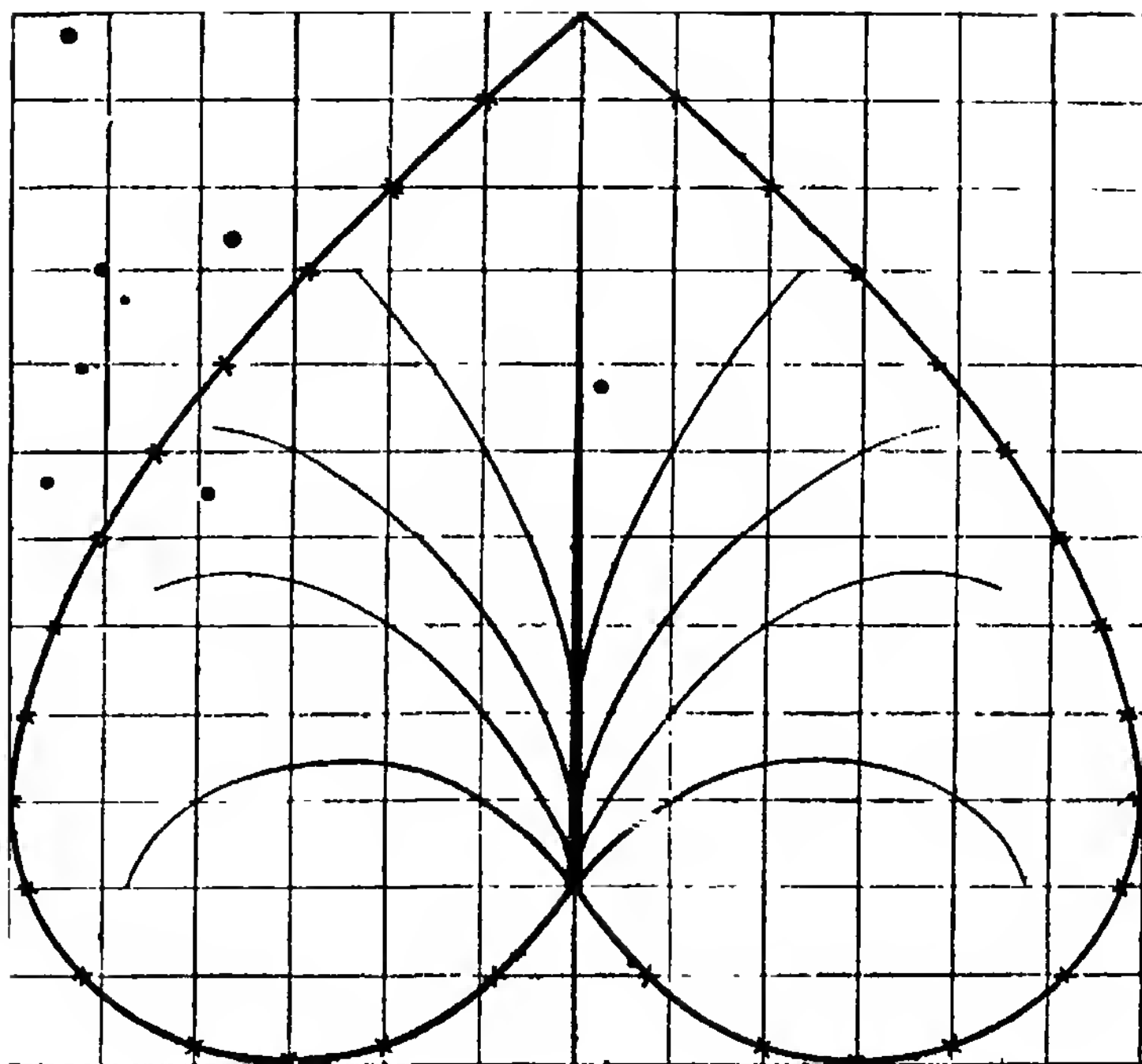
Draw lightly a square of three inches (twelve small squares) side on the squared paper.

Draw lightly the middle line from top to bottom of square.

Copy outline of leaf by help of squares (first marking points where outline crosses each line of squares).

Cut out with scissors when neatly drawn.

Mark in midrib and some of the veins.





**Exercise XXIII.****PAPER CUTTING—LEAVES.**

**MATERIALS.**—*Small white paper square; coloured paper square; ruler; lead pencil; scissors. [Pressed and mounted or fresh leaves.]*

Find middle points of two opposite edges of white square, and rule line joining the two points.

Draw from actual leaf, or from copy drawn on blackboard, outline of one side of simple leaf (Fig. 1).

Fold paper carefully along middle line (with drawing outside), and press down flat.

Cut through the doubled paper along the drawn curve.

Open out the piece cut to show form of leaf, and mark with pencil midrib and some veins.

Proceed in same way as above on back of coloured paper to draw outline of somewhat differently shaped leaf (Fig. 2), and cut out.

**NOTE.**—In repeating the Exercise, the children might try to reproduce the general outlines of some simple mounted leaves (see figures on p. 47).

FIG. 1.

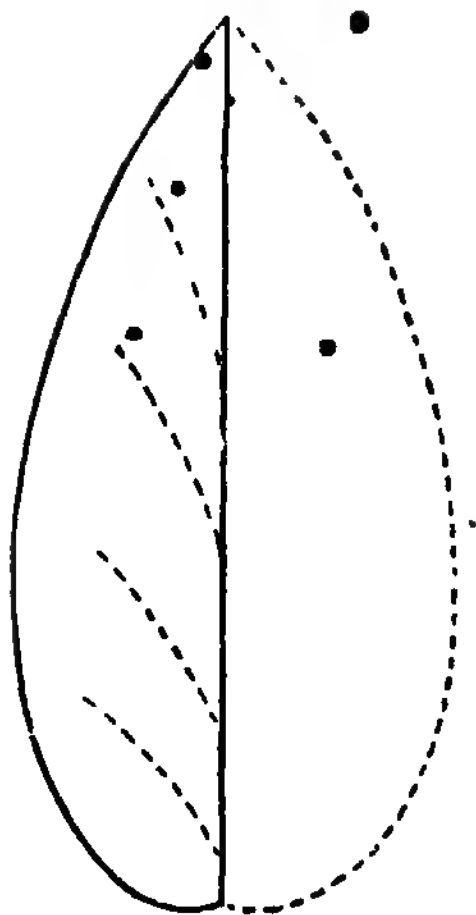
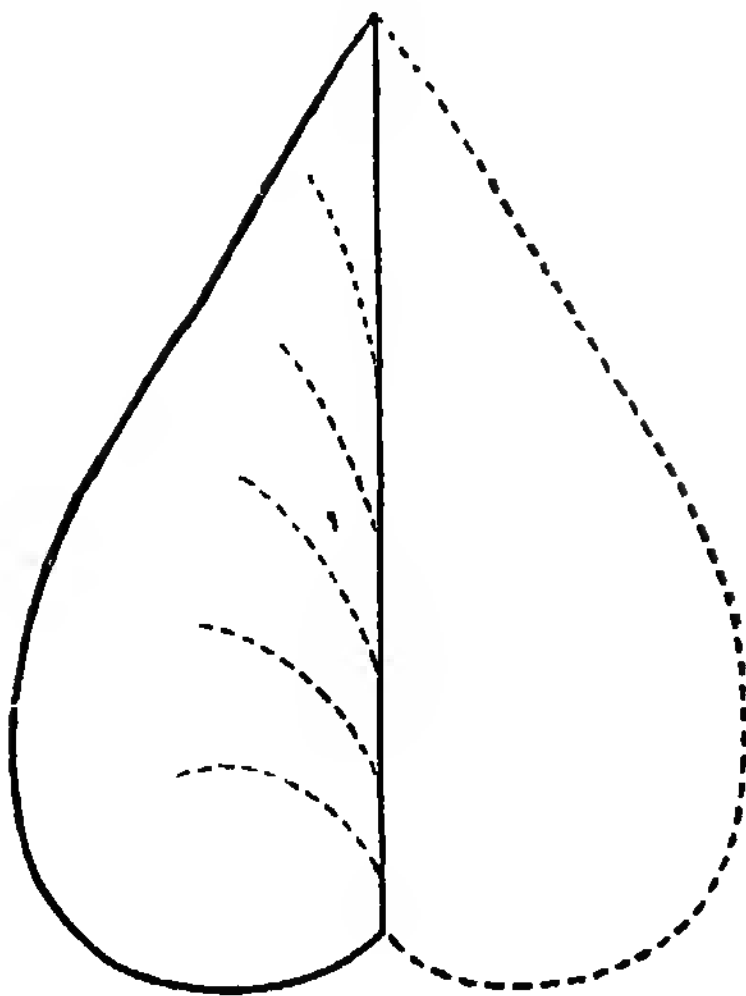


FIG. 2.



**Exercise XXIV.****PAPER CUTTING AND MOUNTING (PLATE II.).**

**MATERIALS.**—*Large white paper square ; small white paper square ; coloured gummed paper square (green by preference) ; scissors ; ruler ; lead pencil ; damp sponge. [A mounted clover leaf would be useful to suggest the general arrangement.]*

Fold and cut the two small paper squares along middle lines, each into four squares (Fig. 1).

On one small white square outline and cut leaf (Fig. 1), as in Exercise XXIII., from copy on blackboard.

Repeat this drawing and cutting on the other small white squares till a well-shaped leaf is obtained.

With the best-shaped white leaf as pattern cut out three coloured leaves.

Lay the coloured leaves on the large square to form pattern of compound leaf, and mount in position (Fig. 2).

Outline a simple stalk with pencil, or cut out a curved coloured strip, and mount (Plate ii. Fig. 2).

FIG. 1.

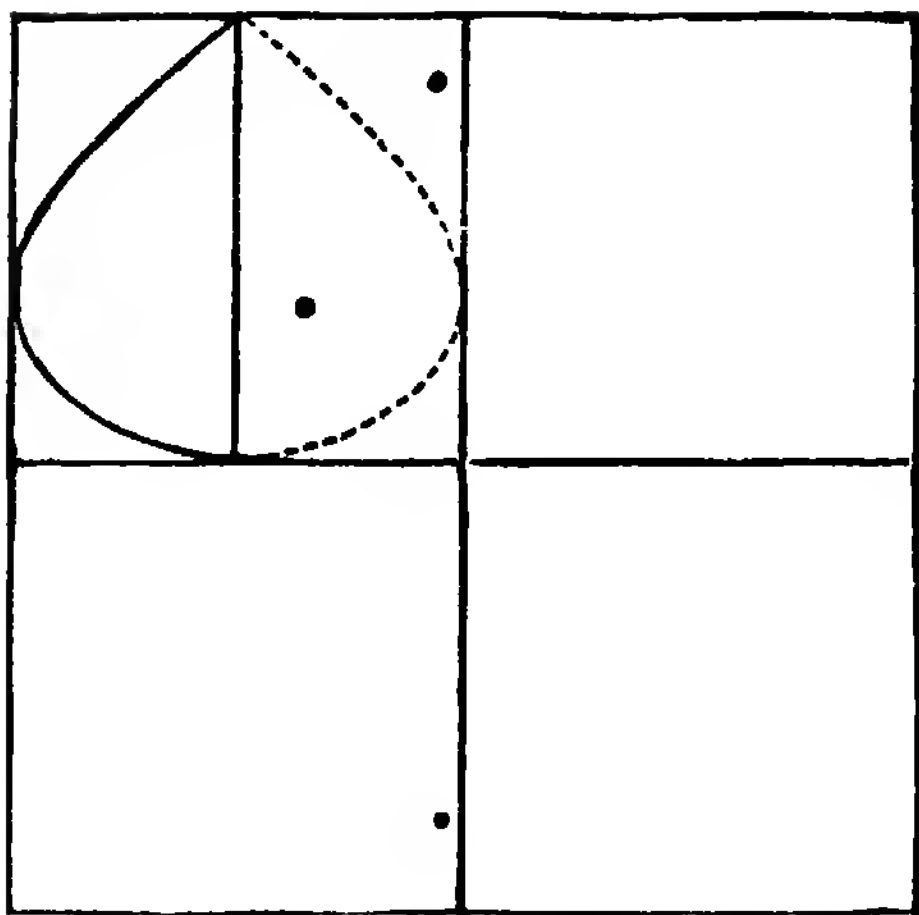
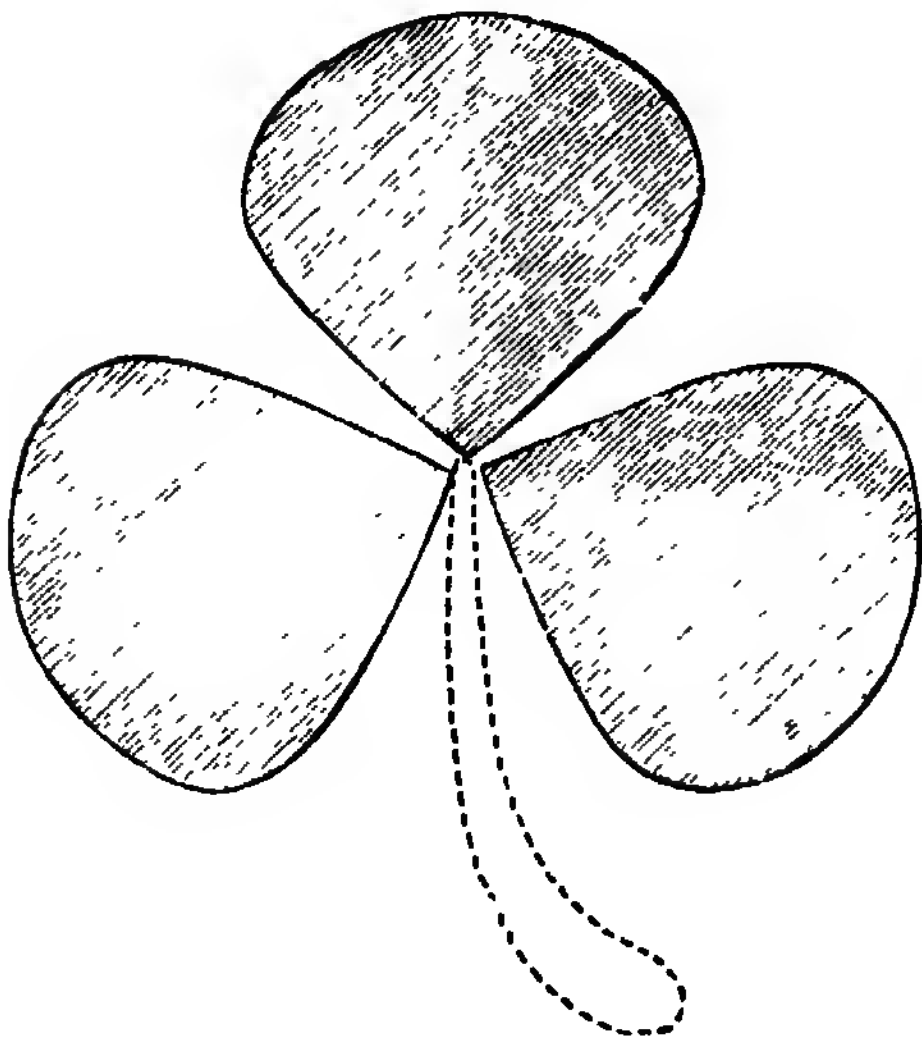


FIG. 2.



**Exercise XXV.****WIRE MODELLING.**

**MATERIALS.**—*Piece of thin wire about twenty inches long* (see Note F, p. 5); *rule; scissors; slate and pencil.*

Straighten out wire, if necessary, and measure total length in inches.

Make wire into small coil without twisting the end.

Draw with rule on slate letter L, having longer arm two inches and shorter one inch.

Cut off piece of wire required to make letter L same size, straighten and bend at right angles. (In bending the wire, hold tightly between thumb and forefinger, and bend over thumb-nail.)

Rule figure on slate similar to Fig. 2, each line being one inch long.

Calculate length of wire required to make similar figure, cut off, straighten, and bend at proper points.

Rule letter V on slate, each arm being two inches long.

Cut off length of wire required to make same letter, straighten and bend at middle point. (It will not be possible to make a very sharp bend at the angle, but the sides of the V should be kept straight.)

Lay the wire models over the drawings to see if they agree.

(With the remaining piece of wire the children might be allowed to make any other letter or object they pleased, first, however, drawing the figure on their slate.)

FIG. 1.

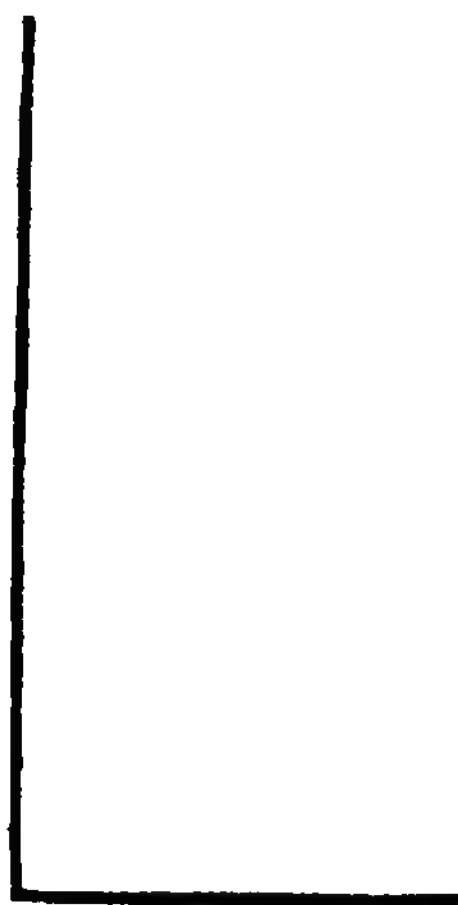


FIG. 2

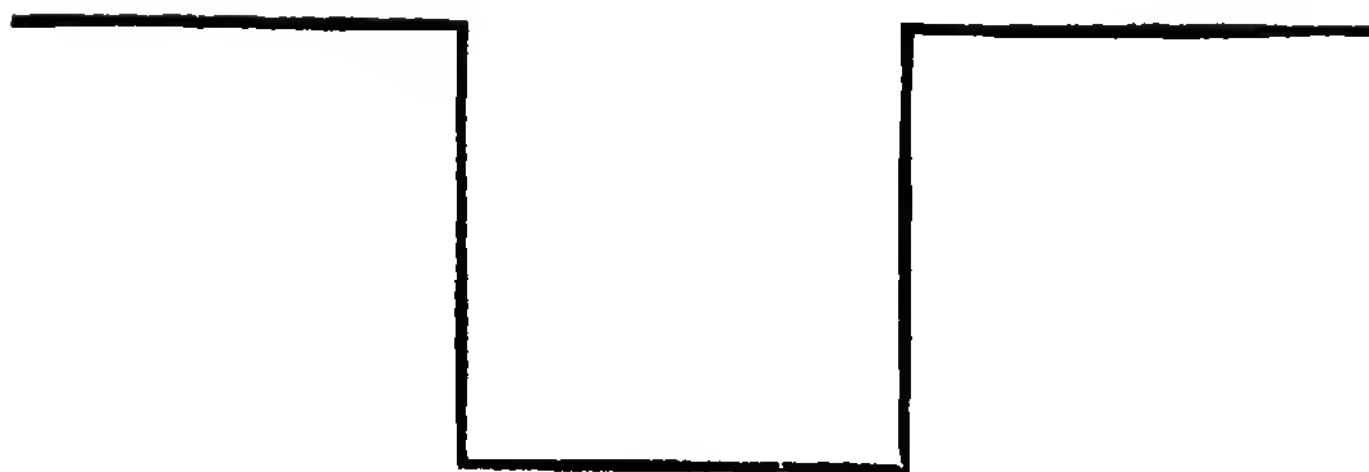
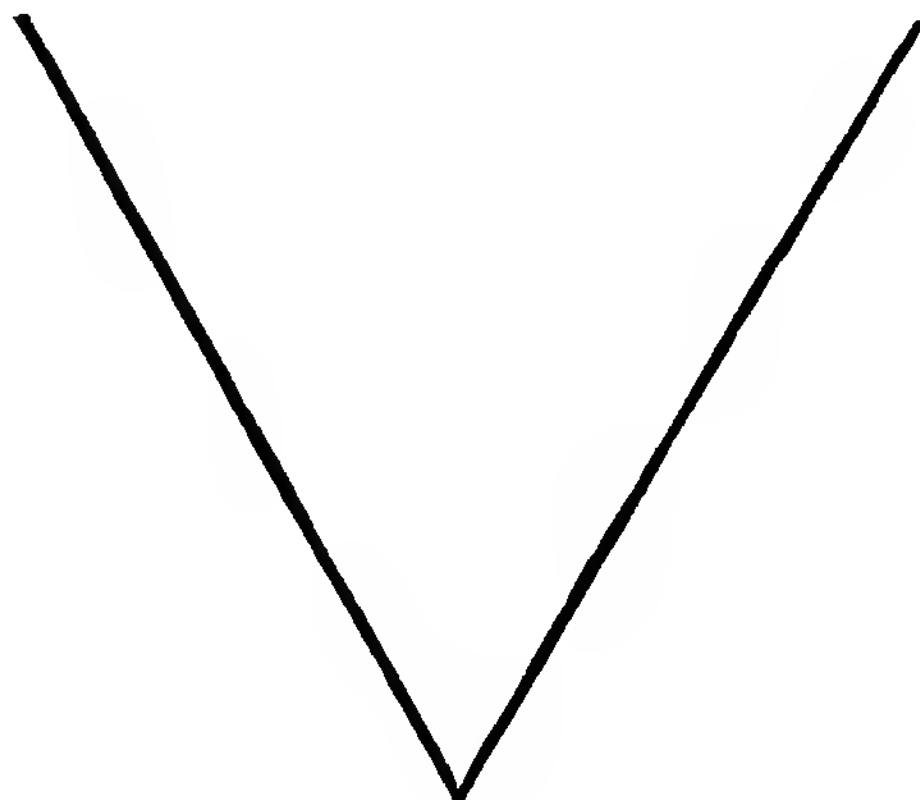


FIG. 3.



•  
**Exercise XXVI.**

WIRE MODELLING—LETTERS.

**MATERIALS.**—*Coil of thin wire (or piece at least two feet long) ; scissors ; rule ; piece of white paper to lay wire on.*

Cut off four pieces of wire each six inches long, and straighten out.

Draw one piece between finger and thumb (or over slate frame) to give it a curved form, and model it into shape of C with small loop at end. (Make it so as to lie flat on desk.)

Estimate middle point of second piece ; hold at estimated middle point and test with rule.

Bend each half of this second piece into curve to form letter S. Find middle point of third piece as before, and bend at right angles there.

Bend half of the third piece into curve to form P twisting end round straight piece to fasten it.

Hold fourth piece at point, so that one part is twice as long as other, and test with rule ; bend sharply at right angles there.

Bend longer portion of this fourth piece to form R ; then convert to B.

C S

P R B



**Exercise XXVII.****WIRE MODELLING—LEAVES.**

**MATERIALS.**—*Piece of wire about thirty inches long; rule; scissors.*

Measure length of wire, and cut into lengths of six inches.

Draw wire between finger and thumb, or over slate frame, to give it a curved form.

Make one piece into a circle, as nearly as possible, fastening the ends by twisting them together.

With two other pieces make the outline of leaves of same shape as in Exercises XXII. and XXIII. (This might first be attempted from memory, and then if necessary from copy drawn on blackboard.)

Attach small piece of wire to leaves to represent stalks.

Make fourth piece of wire into object chosen by children themselves.

**Exercise XXVIII.**

CLAY MODELLING—LEAVES.

MATERIALS.—*Moist clay ; modeling board ; damp sponge ; modelling tool.*  
• (See Note H, p. 7.)

Divide clay into two approximately equal pieces.

Flatten out clay on board with fingers into approximate shape  
(and size) of one of the leaves of Exercise XXIII.

Finish off shape of leaf by aid of modelling tool.

Attach simple stalk, and mark in veins.

Similarly model other leaf of Exercise XXIII., or copy simple  
dried and mounted leaf shown.

NOTE.—A further exercise to model the group of three simple leaflets of  
Exercise XXIV. might follow the present one.

**Exercise XXIX.**

PAPER MOUNTING—CHIEF POINTS OF COMPASS (PLATE II.).

*MATERIALS.—Large white paper square; three differently coloured gummed squares (to go well together, one being light coloured for central square); rule; scissors; lead pencil; damp sponge.*

Find middle point of each edge of large paper square by means of rule, and mark.

Rule faint pencil lines joining opposite marked points; also rule faintly the diagonals.

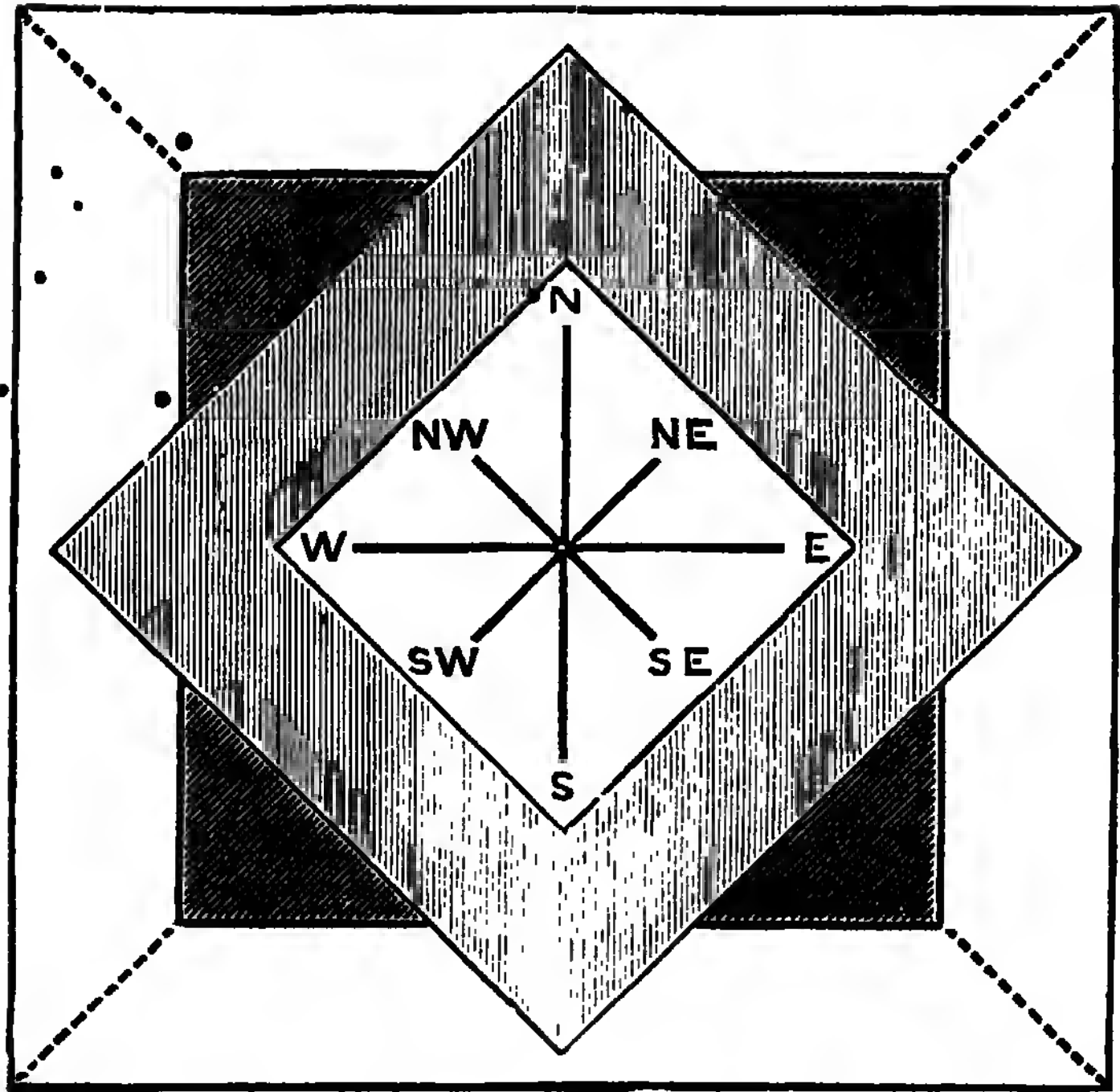
Mount one gummed square symmetrically, with corners on ruled diagonals of large square and sides parallel.

Mount second gummed square symmetrically over first, but with corners on ruled middle lines of large square.

Carefully fold third (light) coloured gummed square along middle lines to form four small squares. (One light-coloured square might therefore serve for four children.)

Mount small light-coloured square symmetrically in centre of, and with sides parallel to, last mounted square.

Rule lines on central square in direction of its diagonals, and also in direction of diagonals of first mounted square; leaving space sufficient for printing in letters N, E, S, W. (Print also letters for intermediate points N.E., N.W.; S.E., S.W., if children understand them.)



**Exercise XXX.****DRAWING, PAPER-CUTTING AND MOUNTING.**

**MATERIALS.** — *Large white paper square ; three differently coloured-gummed paper squares ; squared drawing paper ; lead pencil ; scissors ; damp sponge.*

Draw on squared drawing paper from dictation a square with  $3\frac{1}{2}$  inches (14 squares) side.

Draw lines joining middle points of sides of square thus drawn.

Draw smaller square inside and with sides parallel to those of second. (The position of this third square might be left to the children themselves to determine ; or they might be told to make its corners at a distance of three squares from the corners of the second square.)

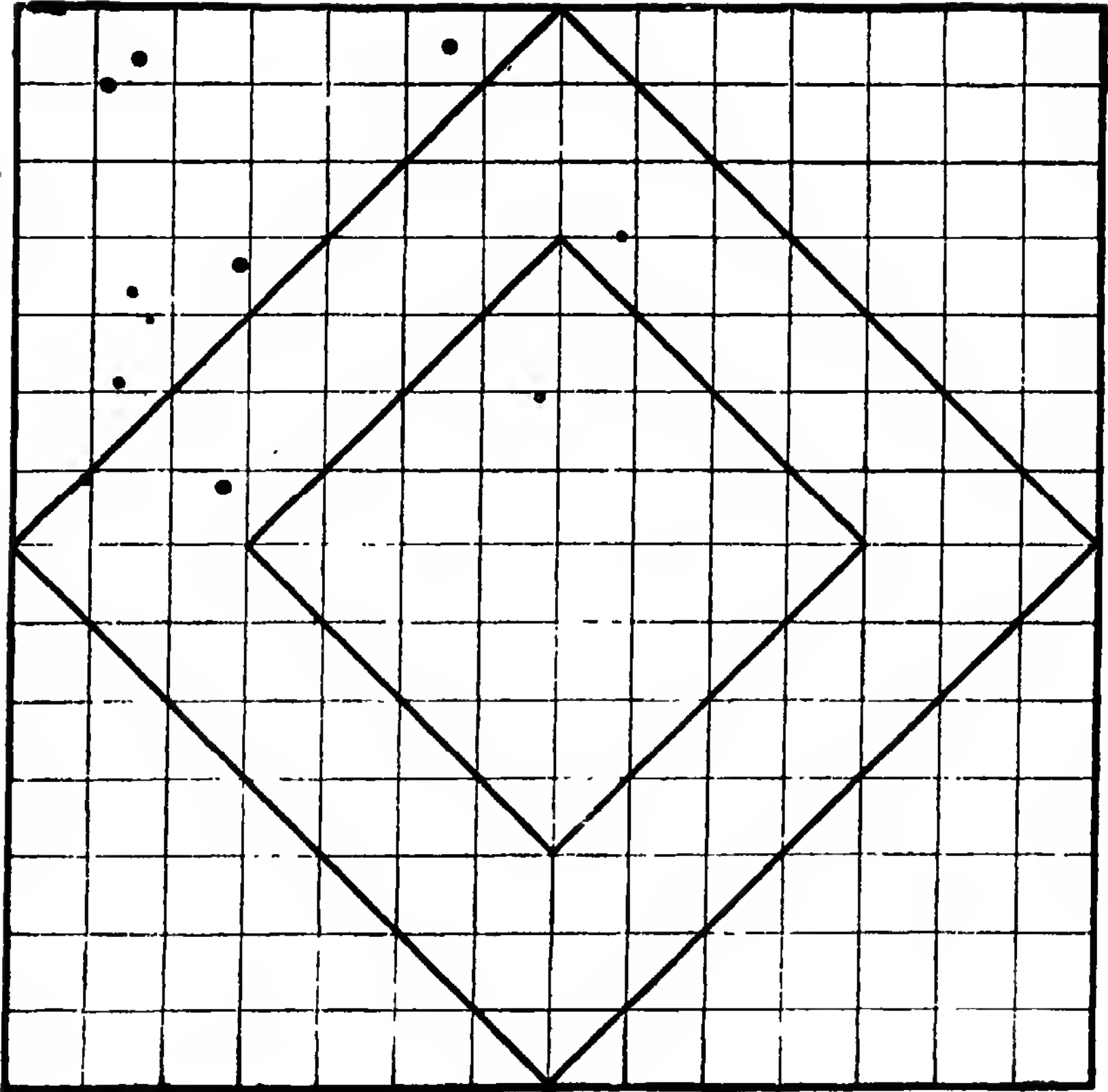
Cut out largest square from the drawing, and, using it as a pattern, cut similar piece from one of coloured squares.

From the large square first cut from the drawing, cut out next largest square, and use it as a pattern to cut similar piece from second coloured square.

Repeat same steps with smallest square.

Lay coloured squares so cut out over each other on white square, so as to reproduce the pattern of the drawing.

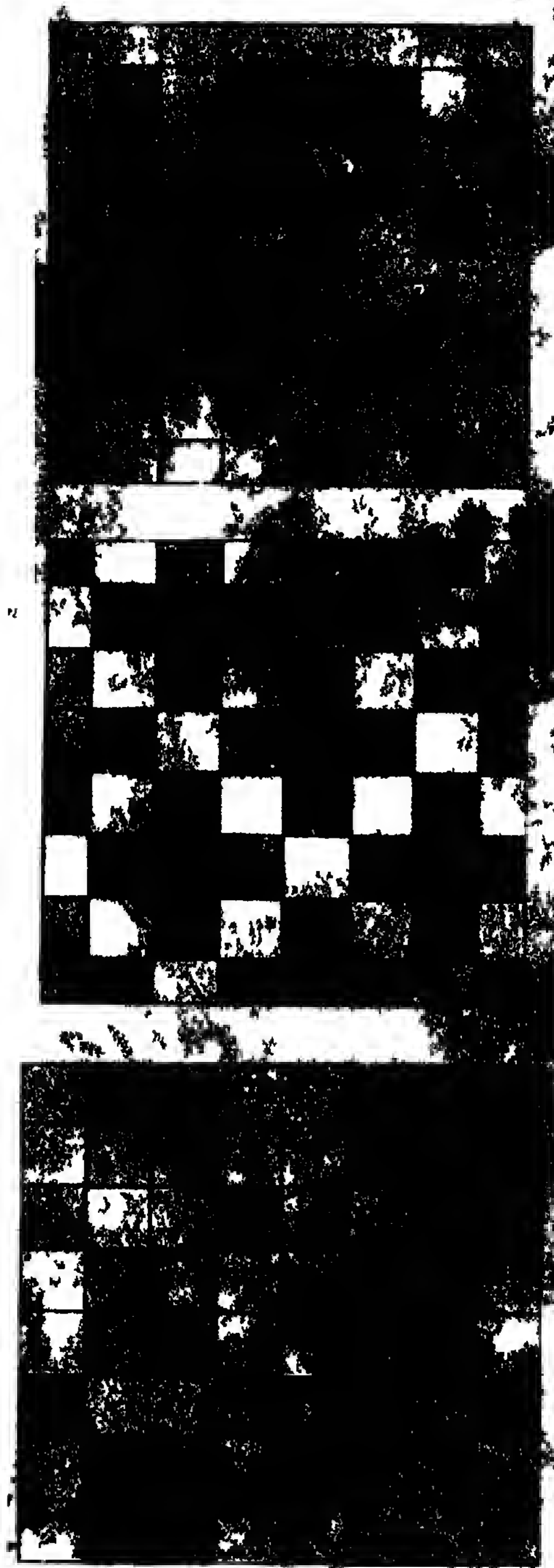
Mount the coloured squares in position.











SECOND SERIES.



## • LIST OF APPARATUS AND MATERIALS.

[Those marked with \* are the same as used for the First Series.]

- \* Large white paper square, 6" side.
- Sheets of white paper (or leaves of ordinary exercise-book),  
8" × 6".
- \* Paper strips, 12" long by  $\frac{1}{2}$ " wide.
- Plain white cards, 4 $\frac{1}{2}$ " × 3".
- \* Squared drawing paper (quarter-inch squares), pieces 5  
square.
- \* Coloured (various) paper squares, 4" side, gummed on back.  
(*Note D*, p. 4.)
- Boxes of crayons, with holders and stumps. (*Note I*, p. 68.)
- \* Thin soft copper wire, No. 26 gauge. (*Note F*, p. 5.)
- Short *wide* wooden laths, 5" ×  $\frac{3}{8}$ ".
- \* Modelling clay. (*Note G*, p. 6.)
- \* Modelling board.
- \* Modelling tool. (*Note H*, p. 7.)
- \* Earthenware vessel with lid, for holding moist clay.
- \* Smooth square wood blocks, for rolling clay, 3", by  $\frac{1}{2}$ " thick.
- \* Rule, 12" long (marked to quarter-inches).
- \* Lead pencil.
- \* Scissors. (*Note C*, p. 4.)
- \* Circular disc, 3" diameter, by preference of metal.
- \* Square disc, 3" side, by preference of metal.
- \* Series of various-coloured wools in bag. (*Note E*, p. 5.)
- \* Teacher's corresponding series of wool skeins.
- \* Thin string, for cutting clay.
- Drawing pins.
- \* Small sponges.

## NOTES ON THE APPARATUS AND MATERIALS, AND THEIR USE.

The notes which follow the list of apparatus and materials for use in the First Series of exercises should be consulted.

- (1) The boxes of *crayons* should contain several (say six) different colours, so that the children may have an opportunity of selecting various combinations according to their tastes.

The crayons may be had enclosed in wood like ordinary lead pencils, but this would involve considerable trouble in sharpening them. It is perhaps best, on the whole, to supply the crayons in short pieces, and to supply also a simple holder for the crayons in order that even very small pieces may be utilized.

In using the crayons, they are first lightly rubbed over the space to be coloured so as to cover it fairly and evenly, and then the crayon powder is rubbed smoothly over the paper with a stump or rubber of leather or soft paper. A separate stump should be kept for each colour. A piece of tissue paper folded several times does very well for rubbing on the powder, but specially prepared paper stumps are to be preferred. (Messrs. Philip, Son; and Nephew, South Castle Street, Liverpool, supply cheap boxes of crayons, with a holder and stump for each colour.)

The crayons should work free from gritty particles, and should be kept in a dry place.



**Exercise I.****LAYING AND FIXING LATHS.**

**MATERIALS.**—*Four short wide wooden laths; piece of coloured gummed paper (half ordinary square); scissors.*

Test laths to see that all are of same dimensions. (Note breadth as well as length.)

Lay laths to form square (Fig. 1). (See that all angles are right angles.)

Lay again to form square (Fig. 2), with ends equally projecting about  $\frac{3}{4}$ ", without measurement. (When the latter operation is correctly performed, the laths might be temporarily fastened together, so as to be taken up in the hand, as follows :—)

Fold coloured gummed paper into two squares, and cut one square into eight equal strips.

Fasten one paper strip at each corner across the lath lying uppermost.

Fasten second strip across first symmetrically. (This is done only for the appearance.)

Cut more strips of gummed paper and fasten the laths on the reverse side, in the same manner as before.

FIG. 1.

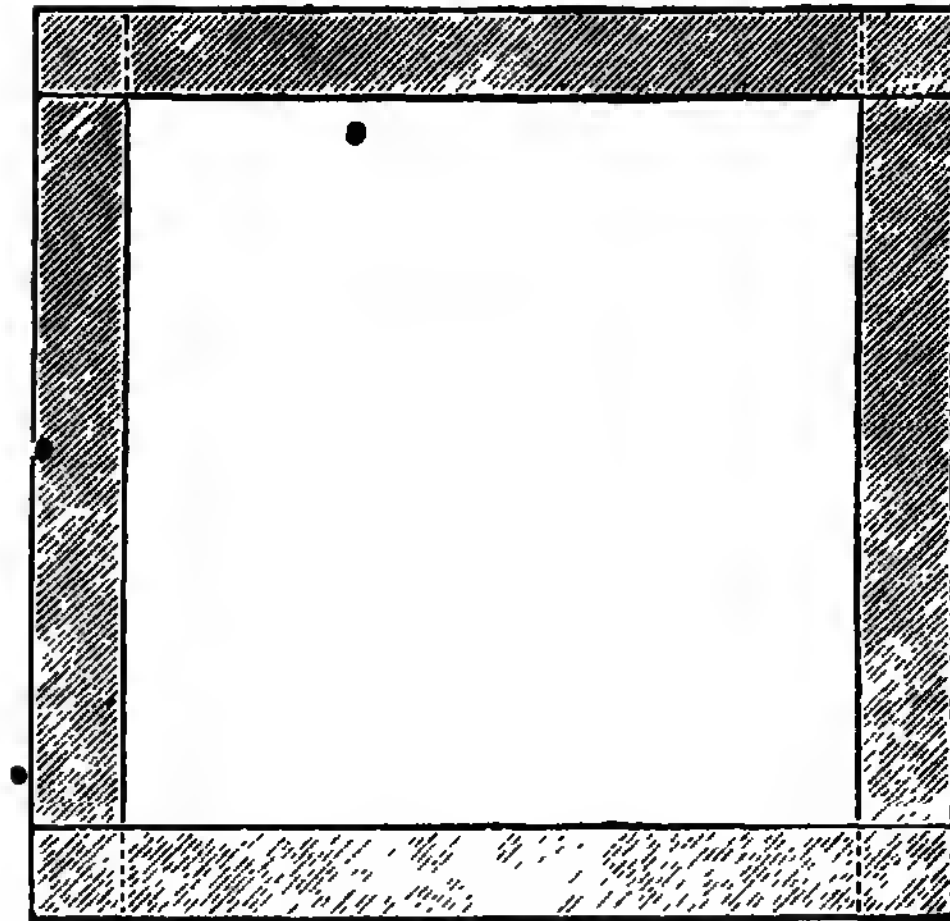
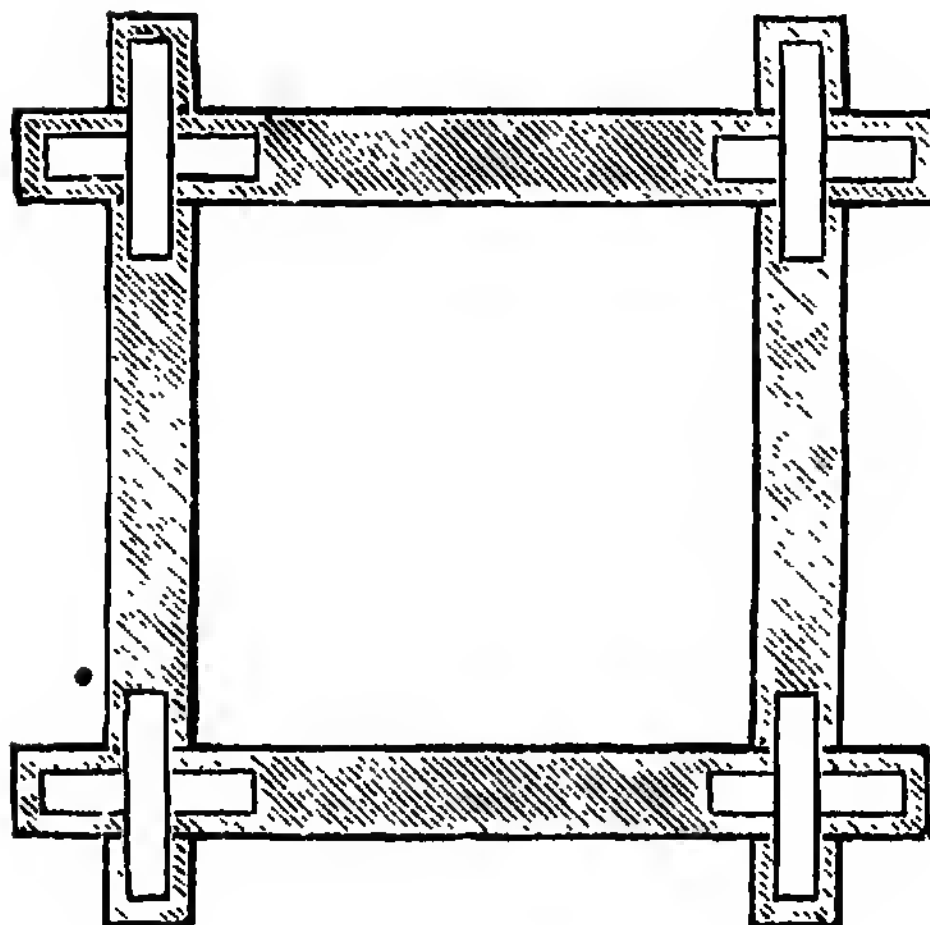


FIG. 2.





**Exercise II.****PAPER CUTTING AND MOUNTING.**

**MATERIALS.**—*Large white paper square ; coloured gummed square ; rule ; pencil ; scissors ; damp sponge.*

Fold coloured square accurately down middle line (coloured side inwards) and crease well. (*See Note D, p. 4.*)

Cut carefully with scissors along creased line. (*See Note C, p. 4.*)

Fold each half again lengthwise, crease, and cut.

Fold each piece again lengthwise, crease, and cut so as to get eight equal strips.

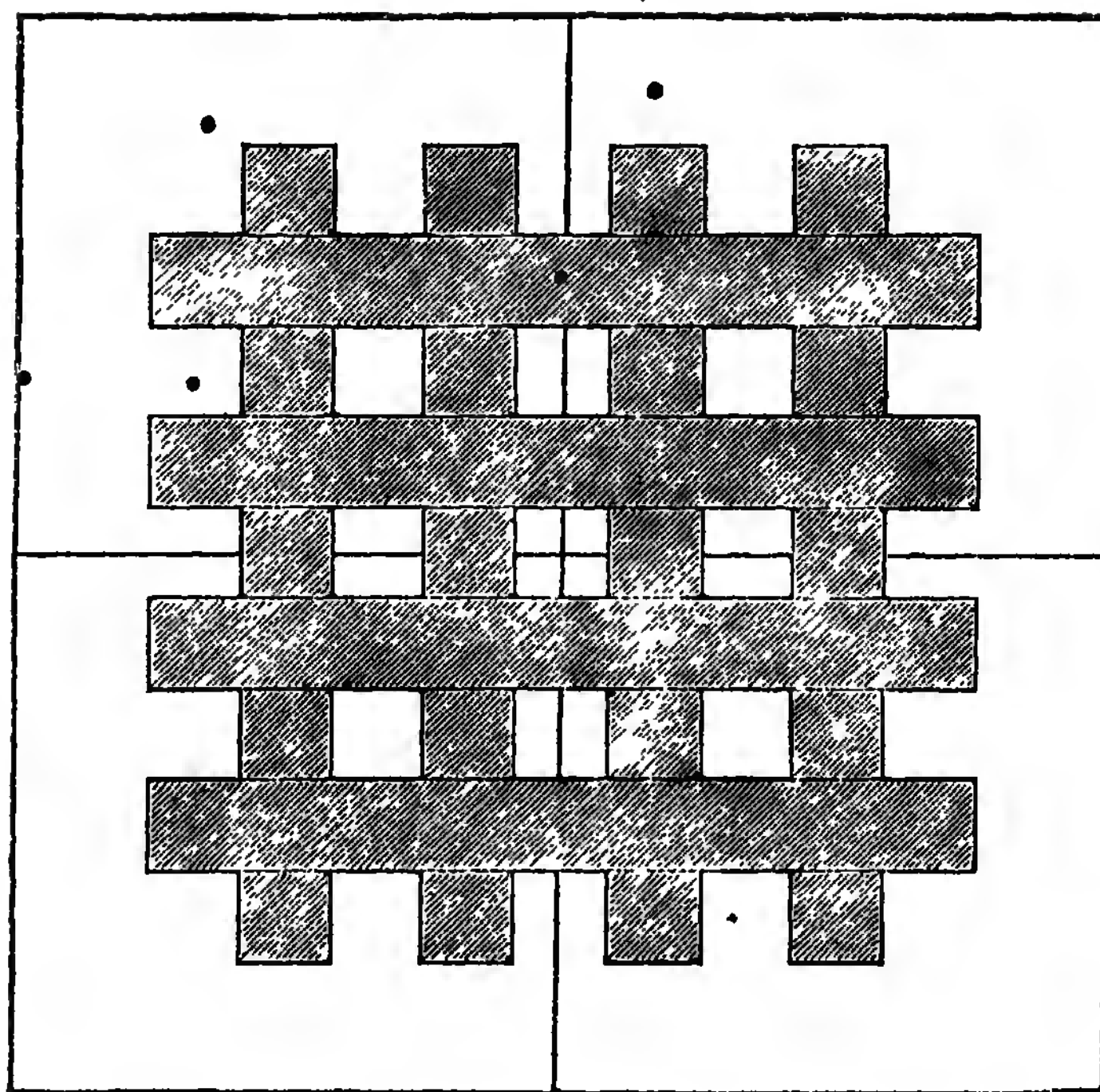
Find middle point of sides of white square and rule faint lines joining opposite points.

Mount two strips on opposite sides of, and parallel to, middle line, leaving space between strips about equal to width of one strip (see figure).

Mount two other strips parallel, one on each side former, and at equal distance.

Mount other four strips across in similar manner.

Note nine equal small squares.



**Exercise III.****CUTTING PAPER STRIPS TO SIZE.**

**MATERIALS.** — *Paper strip at least 12" long; scissors; rule; lead pencil.*

Measure strip, and, if necessary, cut to make it exactly 12" long. Mark point one inch from end of strip, fold there and cut off piece one inch long.

Fold down piece twice as long as last (by estimation); test it with rule, correct, and cut off.

Lay end to end pieces 1" and 2" long, and fold down piece 3" long by estimation; test, correct, and cut off.

Calculate length of remaining portion of strip and test.

From longest strip cut off piece half-inch long by measurement.

Cut off another half-inch from strip by estimation.

Cut off by estimation (judging by appearance of pieces already cut) pieces respectively 1", 2", and  $1\frac{1}{2}$ " long, and test them by the rule.

Lay all the pieces in order of size, and state length of any one pointed out. (The length might be written in pencil on each piece, instead of merely requiring them to state the length of a piece when pointed out.)



**Exercise IV.****PAPER CUTTING AND MOUNTING.**

**MATERIALS.**—*Large white paper square ; coloured gummed square ; circular metal disc ; scissors ; rule ; lead pencil ; damp sponge.*

Draw outline circle (by tracing round disc) on back of gummed square. (See that sharp point of pencil is kept close to edge of disc.)

Carefully cut out the outlined circle.

Cut two narrow strips (about  $\frac{1}{4}$ " wide) from sides of coloured paper left from previous cutting.

Fold circle along one diameter, crease, and cut. (Note equality of semicircles.)

Fold each semicircle into two equal parts (quadrants), crease, and cut.

Rule lines parallel to sides of large paper square at distance of 1" (by measurement).

Rule faintly diagonals of inner square.

Mount the two narrow coloured strips along the diagonals, crossing at their centres.

First lay, and then mount, each coloured quadrant, touching sides of ruled square, and with point on middle line of coloured strip (Fig. 1).

**NOTE.**—A variation of this exercise is suggested in Fig. 2, where the outlined circle is folded and cut into eight equal sectors, and these are mounted symmetrically along diagonals and middle lines of square.

FIG. 1

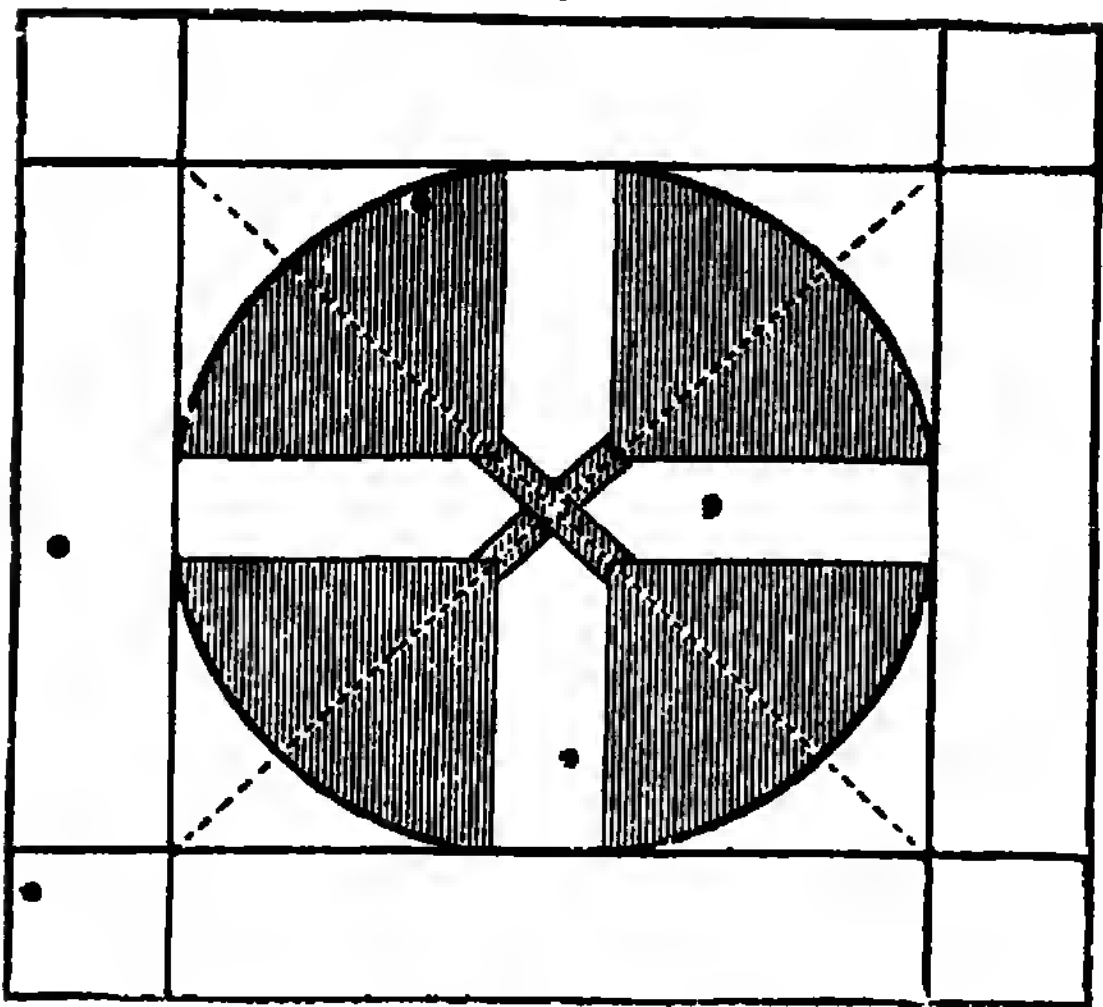
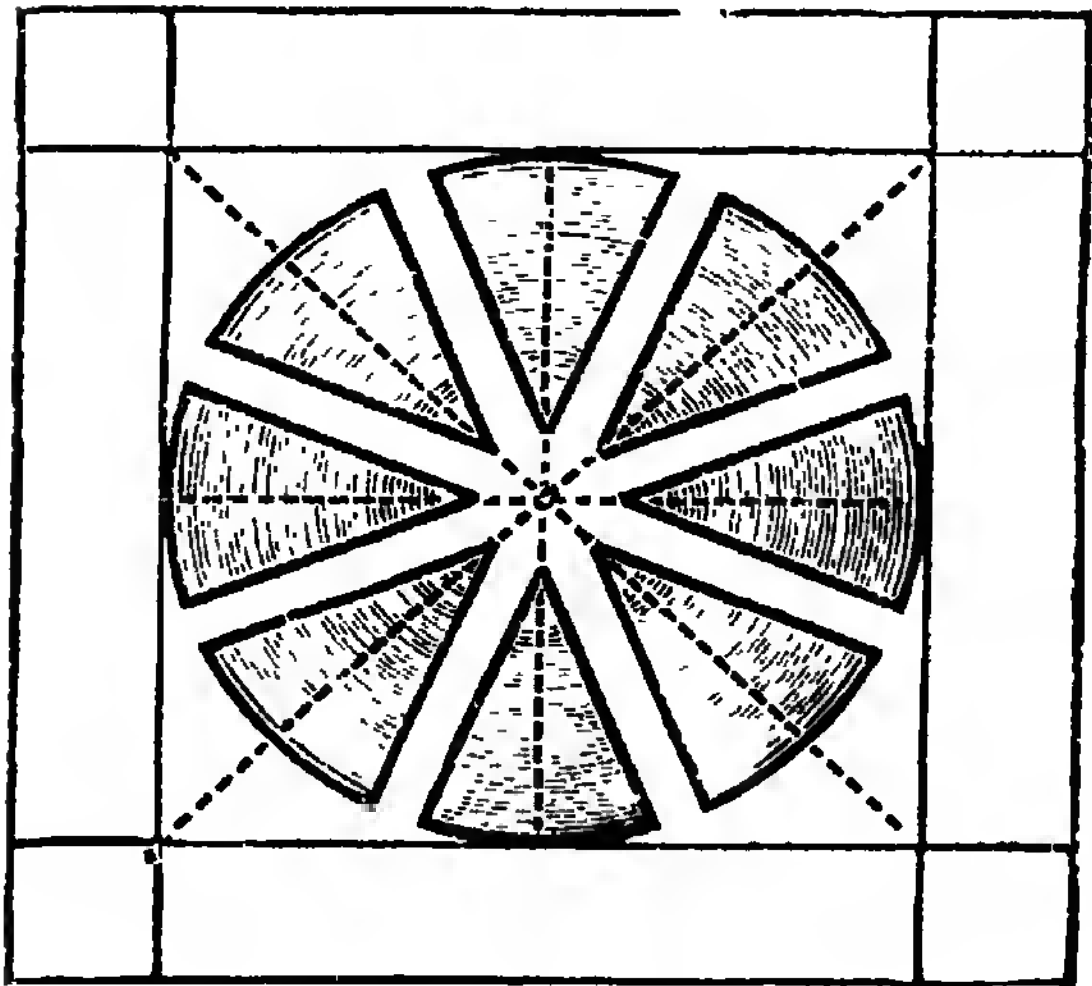


FIG. 2.



**Exercise V.****FOLDING AND TEARING PAPER TO SIZE.**

**MATERIALS.**—*Large white paper square ; rule ; lead pencil ; scissors.*

Measure paper square, and state size.

Mark points on opposite edges of square at distance of 1" from corners, and then fold down strip 1" wide.

Crease strip well, and tear off neatly.

Mark points 1" from one end of strip, fold down there (thus forming square inch), crease, and tear.

Measure all sides of square inch, and write words "square inch" on it.

Fold remaining portion of same strip, without measurement, to form another estimated square inch ; crease, tear, and compare with first.

Fold remainder of strip into square inches.

Mark points on opposite edges of original paper distant 2" from corners ; fold down strip 2" wide, crease, and tear.

Mark points 2" from one end of strip ; fold down there (forming piece two inches square), crease, and tear.

Compare latter square with square inch previously torn, and fold to show that it contains four square inches.

Fold without measurement, on same strip, another piece 2" square ; tear and test.

From remainder of large square, cut (or tear), without folding or measurement, pieces 1" and 2" square respectively, and compare with those previously made.

## **Exercise VI.**

### **COLOUR SORTING.**

**MATERIALS.**—*Series of coloured wools in bag; large white square to lay wools on.* [Teacher's corresponding series of wool skeins.] (See Note E, p. 5.)

Children select coloured wool to match colour of skein shown by teacher.

Select best red, orange, yellow, green, and blue, and lay in that order.

Lay bright blue in middle of paper, then lighter and lighter tints, grading into white.

On other side lay darker shades of blue, grading to black.

Lay red and yellow at distance apart, and lay several intermediate tints in order.

Lay series similarly between green and yellow, or green and blue.

Lay together, or twist together loosely, pairs of colours which form pleasing combination.

**NOTE.**—This lesson should be repeated several times at intervals.



**Exercise VII.****DRAWING AND COLOURING**

**MATERIALS.**—*Sheet of squared paper ; ruler ; lead pencil; crayons (with holders and stumps). (See Note I, p. 68.)*

Rule lines at equal distance (say one small square) from each edge of square sheet, to form a border.

Rule faintly smaller square, parallel to border lines, say two squares distant. (Let children as far as possible rule these lines from verbal instructions, rather than from copy.)

Rule faintly diagonal square from points opposite middle points of sides of last square, and one square distant.

Rule faintly small oblong, say seven squares by three squares, symmetrically within last-ruled square. (See figure.)

Colour the two squares with two crayons (choosing colours which harmonize), and rubbing colour evenly with stumps.

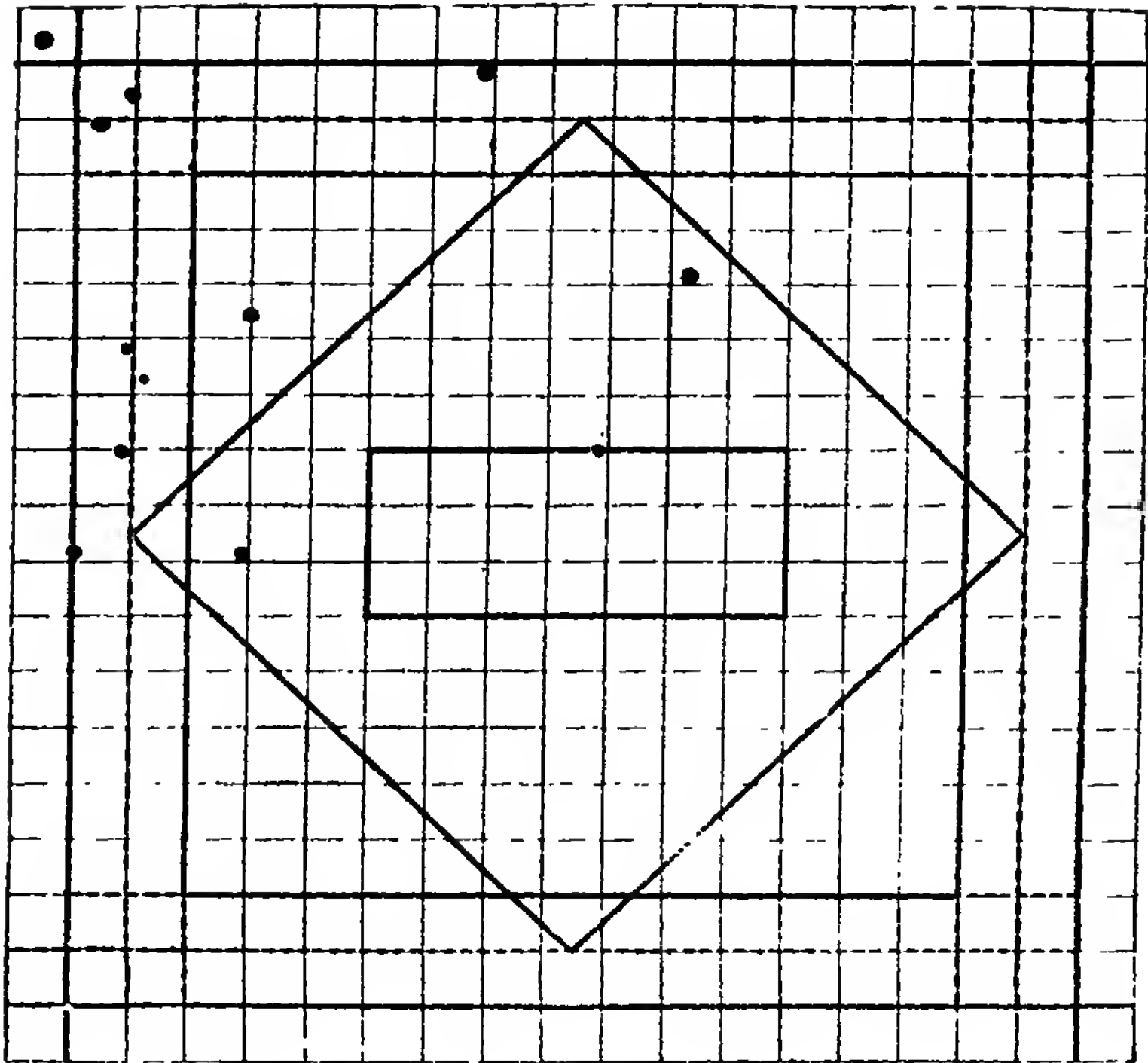
Leave the oblong space uncoloured.

Rule strongly in pencil the lines bordering the colours.

Let each child write his name in the central uncoloured space.

[If there is time, a strip one square wide (shown by dotted lines in figure), outside the first drawn square, might be shaded with black-lead pencil.]

**NOTE.**—This exercise might be repeated on a plain white paper square, the children outlining the two squares to be coloured by means of the model metal squares.



**Exercise VIII.****DRAWING AND COLOURING.**

**MATERIALS.**—*Squared paper ; ruler ; lead pencil ; crayons (with holders and stumps).*

Rule border lines one square distant from edges of paper.

Rule faintly inner square parallel to border lines, and two small squares distant.

Count number of small squares along one side of ruled square, and mark points enclosing the three central small squares on each of the four sides.

Rule faintly lines joining opposite marked points, to form a broad cross.

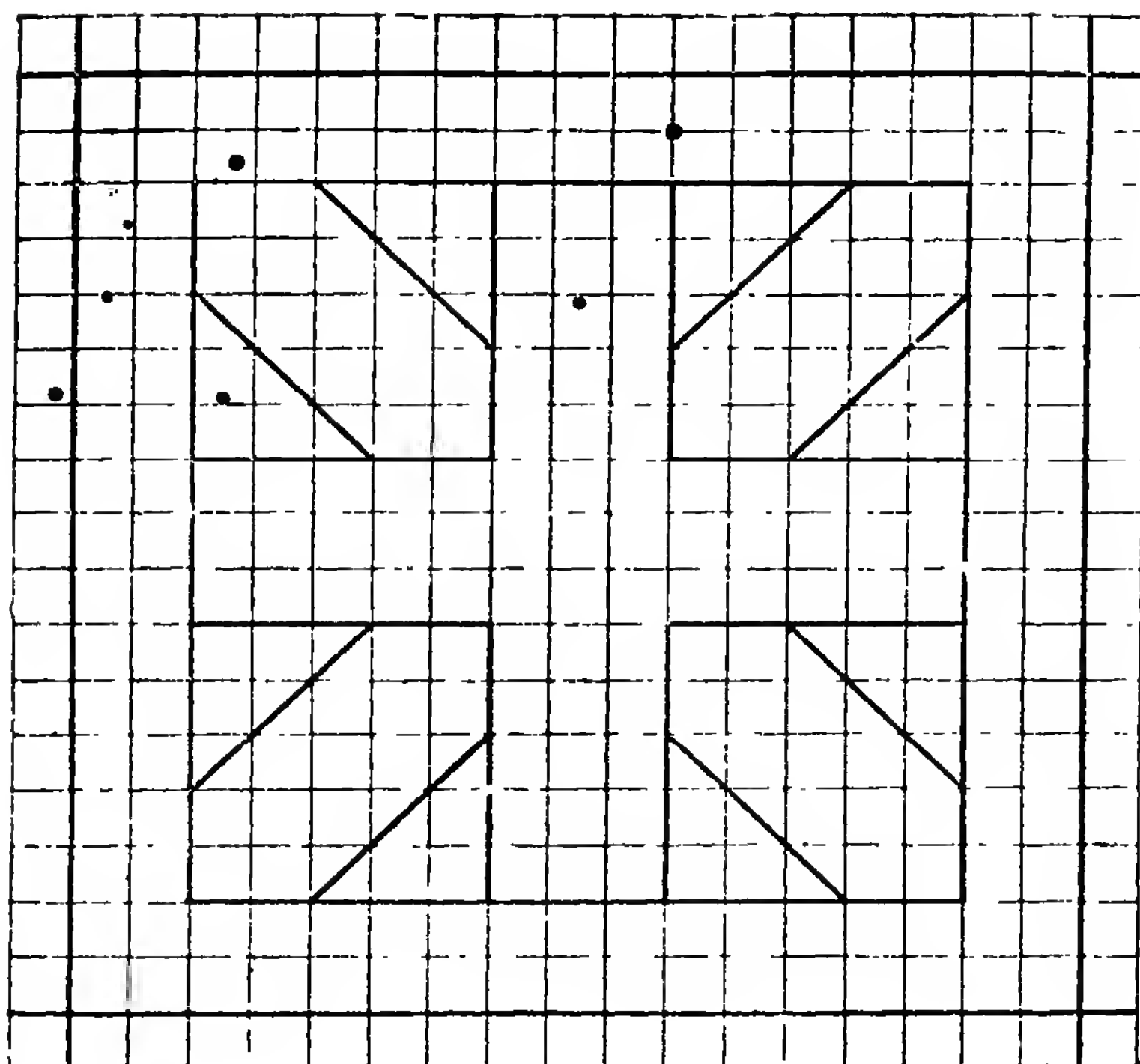
Mark points on sides of ruled square distant two small squares from each corner, and rule faintly lines joining opposite points to form diagonal cross.

Colour first cross with crayon rubbed evenly with stump.

Colour diagonal cross with crayon of different colour, but harmonizing with the first.

Rule strongly the lines bordering the colours.

**NOTE.**—Several interesting exercises may be arranged, in which the Union Jack and various other flags may be drawn and coloured.



**Exercise IX.****FOLDING AND TEARING PAPER SQUARES.**

**MATERIALS.**—*Paper 8" × 6" ; rule ; lead pencil.*

Estimate length of sides of paper, then measure. (The children might first write down their estimate before measuring.)

Measure, fold, and tear a strip one inch wide off one of longer edges.

Measure remaining paper, and state size, viz. 8" × 5".

Fold paper carefully along line A D, bringing point B to edge of paper at C, and making side A B coincide with A C (Fig. 1). Crease to keep it folded there.

Fold down remaining piece along line C D ; crease and tear.

Measure sides of piece A B D C to prove that it is a square.

Fold down and tear off square in similar manner from piece C D F E ; then again from remaining piece another square, and so on, to get four squares. (Note if children have observed that piece then remaining is also a square.)

Measure sides of each square, and write dimensions on each side, e.g. "5 inch square," etc.

Straighten out squares, and lay together to form original piece.

Lay squares symmetrically one on another (Fig. 2).

FIG. 1.

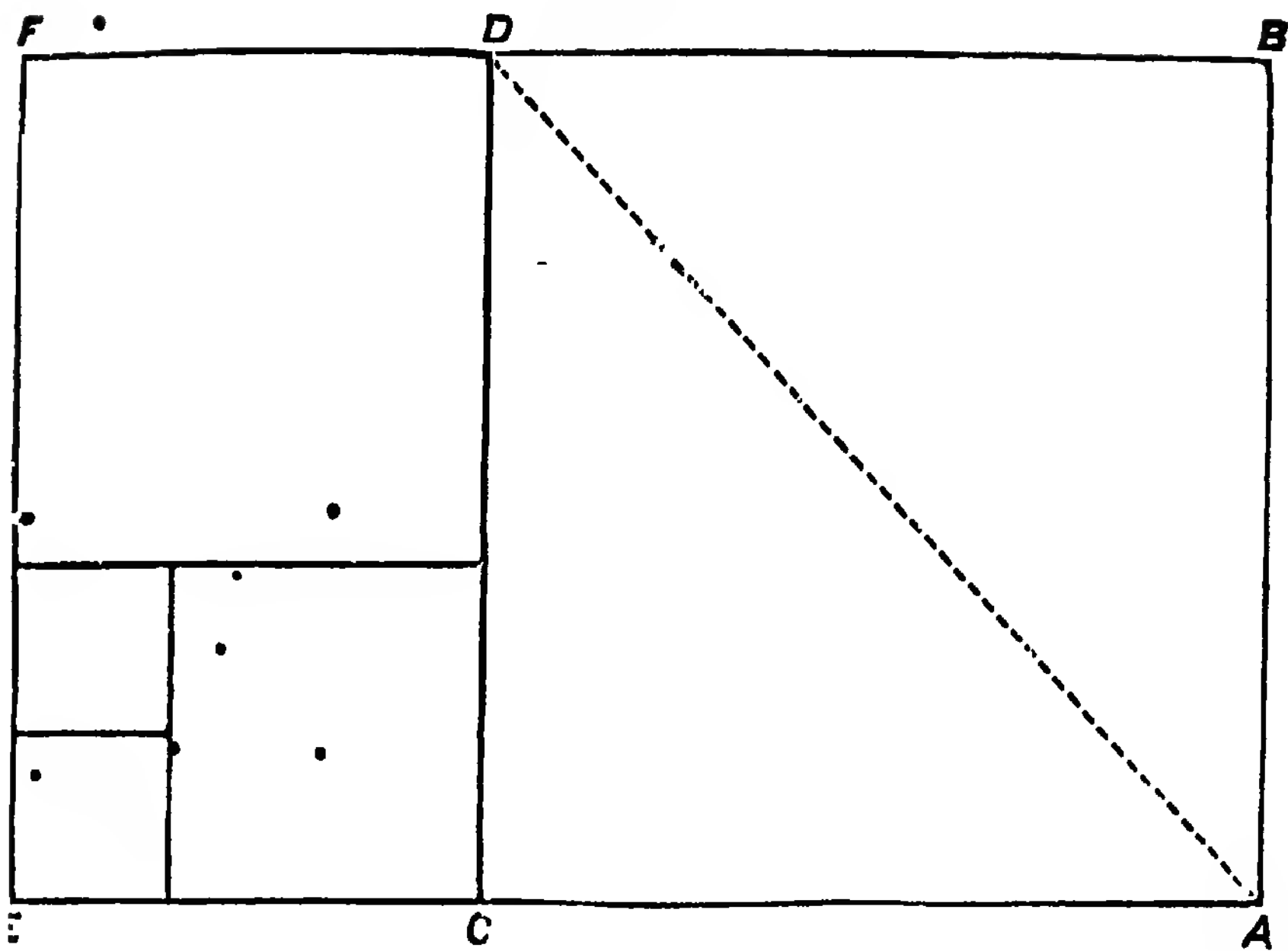
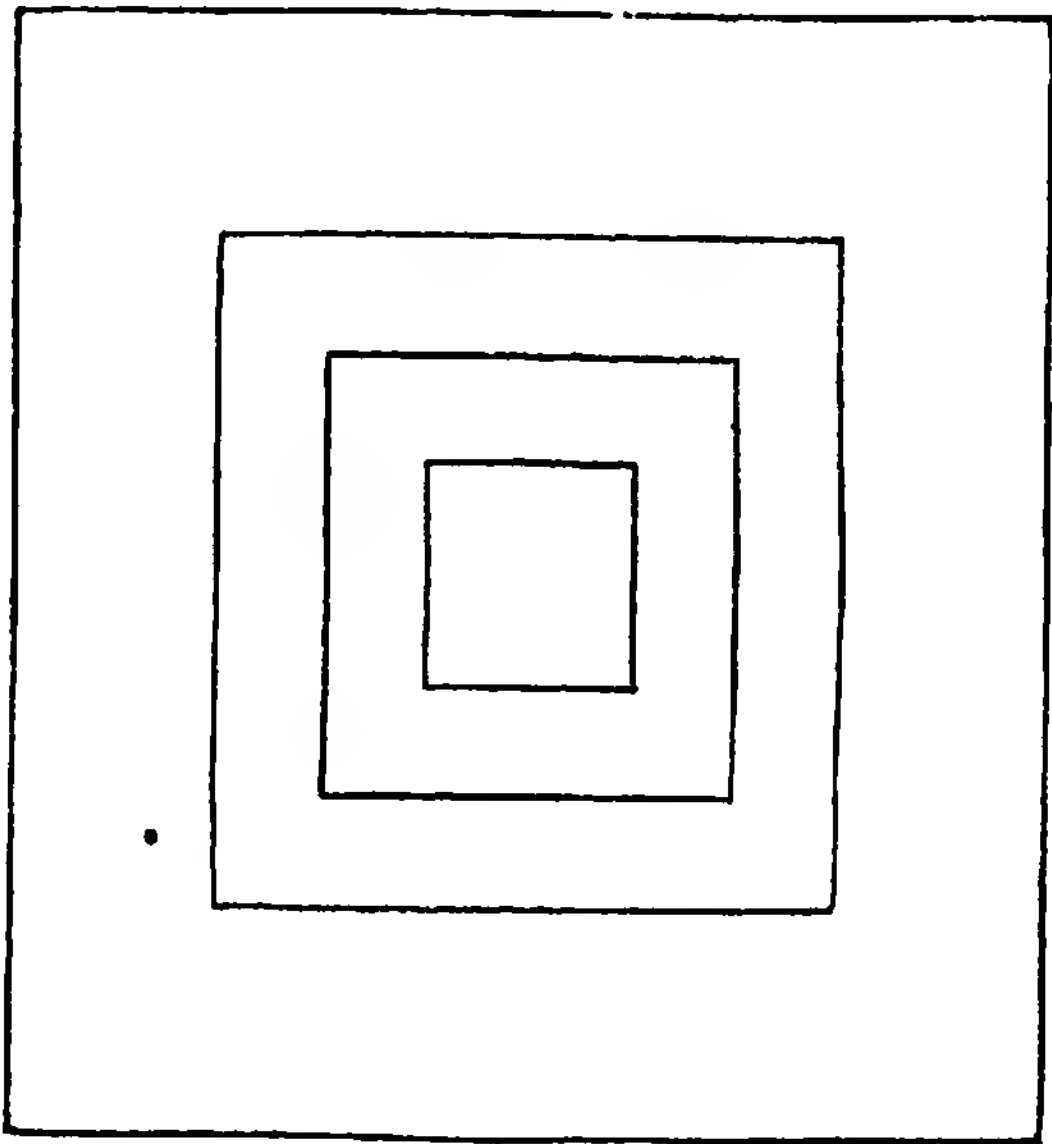


FIG. 2.



**Exercise X.****DRAWING AND COLOURING.**

**MATERIALS.**—*Large white paper square ; ruler ; lead pencil ; model circular disc and square ; crayons.*

(First note that diameter of circular disc is equal to width of model square.)

Lay metal square symmetrically in centre of and with sides parallel to paper square ; and draw the outline.

Lay circular disc symmetrically inside drawn square, and draw its outline.

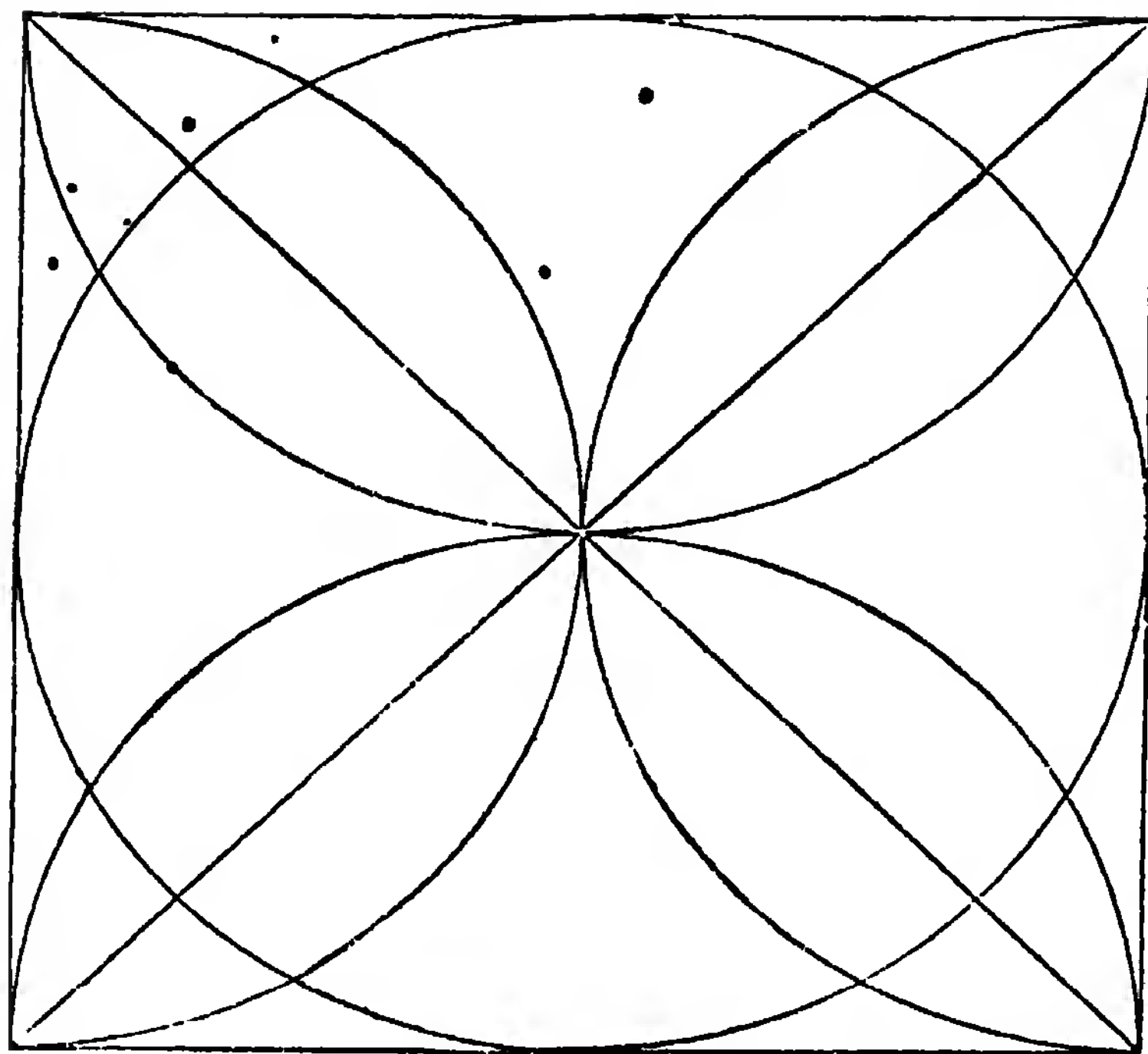
Rule faintly the diagonals of the drawn square, and note that they cross in the centre of the circle. (All the lines in this exercise should be drawn very accurately.)

Lay circle across one side of square, so as to touch other two sides of square and central point, and draw the semicircle (see figure).

Draw semicircle in same manner on each of the other three sides of the square.

Colour with crayons of three colours : viz. the curved arms of cross with one colour, the rest of the circle with a second, and the remaining portions of ruled square with a third.

Rule strongly the lines bordering the colours.





**Exercise XI.****WIRE MODELLING.**

**MATERIALS.**—*Thin wire 18" long (or coil of wire from which to cut lengths) ; scissors ; rule ; squared paper ; pencil. (See Note I, p. 5.)*

Draw on squared paper, from dictation, letter **E** (Fig. 1), extending over same number of squares as shown.

Measure (or calculate) length of wire required to make similar figure ; and cut off that length from piece supplied.

Bend wire at proper points as sharply as possible at right angles. (Note the double piece in the centre.)

Lay bent wire on drawing to test correctness.

Draw on the squared paper the form shown in Fig. 2 to dimensions given.

Measure and cut off length of wire required to form similar figure.

Bend wire at proper points at right angles.

Slightly open out angles to make them like those in the drawing. (Lay the wire as first bent on the drawing, hold down each part in succession on the drawn line while the next succeeding part is moved to its proper position.)

Lay the wire on the drawing to test correctness. (If it is desired to fix either figure in position, little narrow strips of gummed paper may be stuck over two or three of the arms.)

FIG. 1.

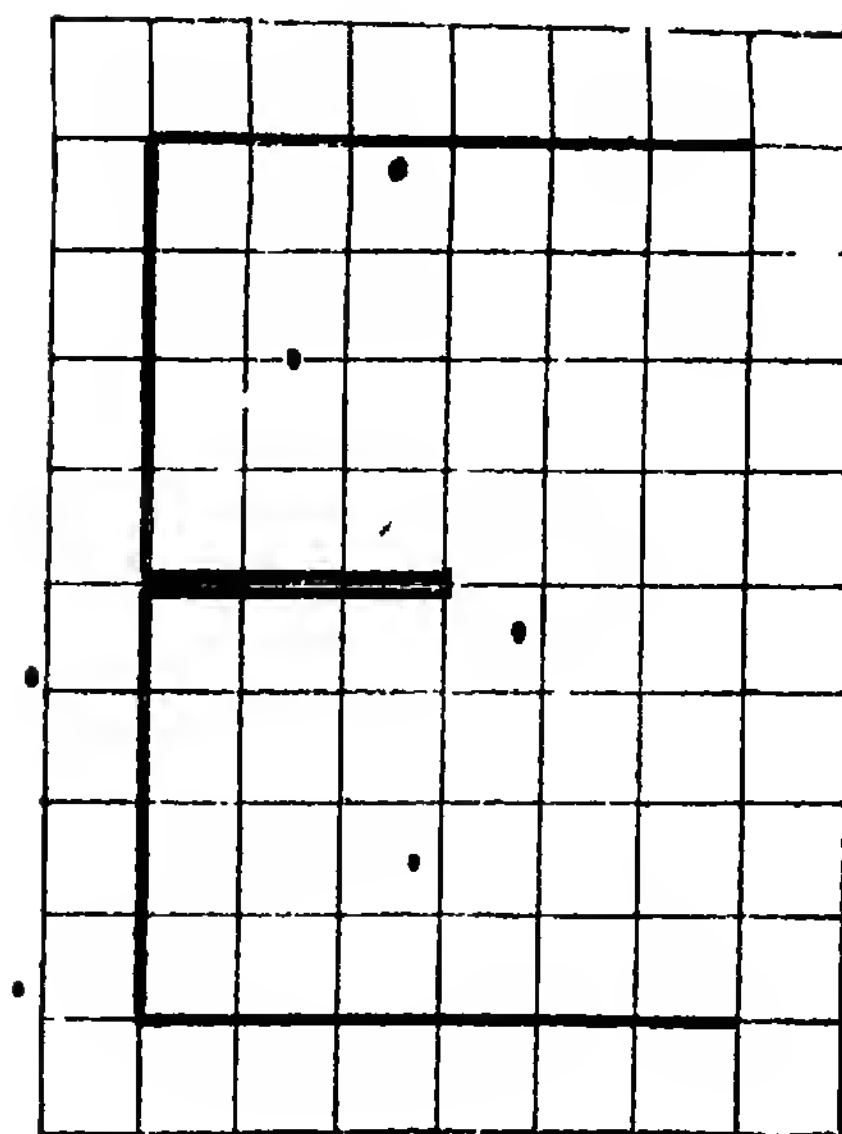
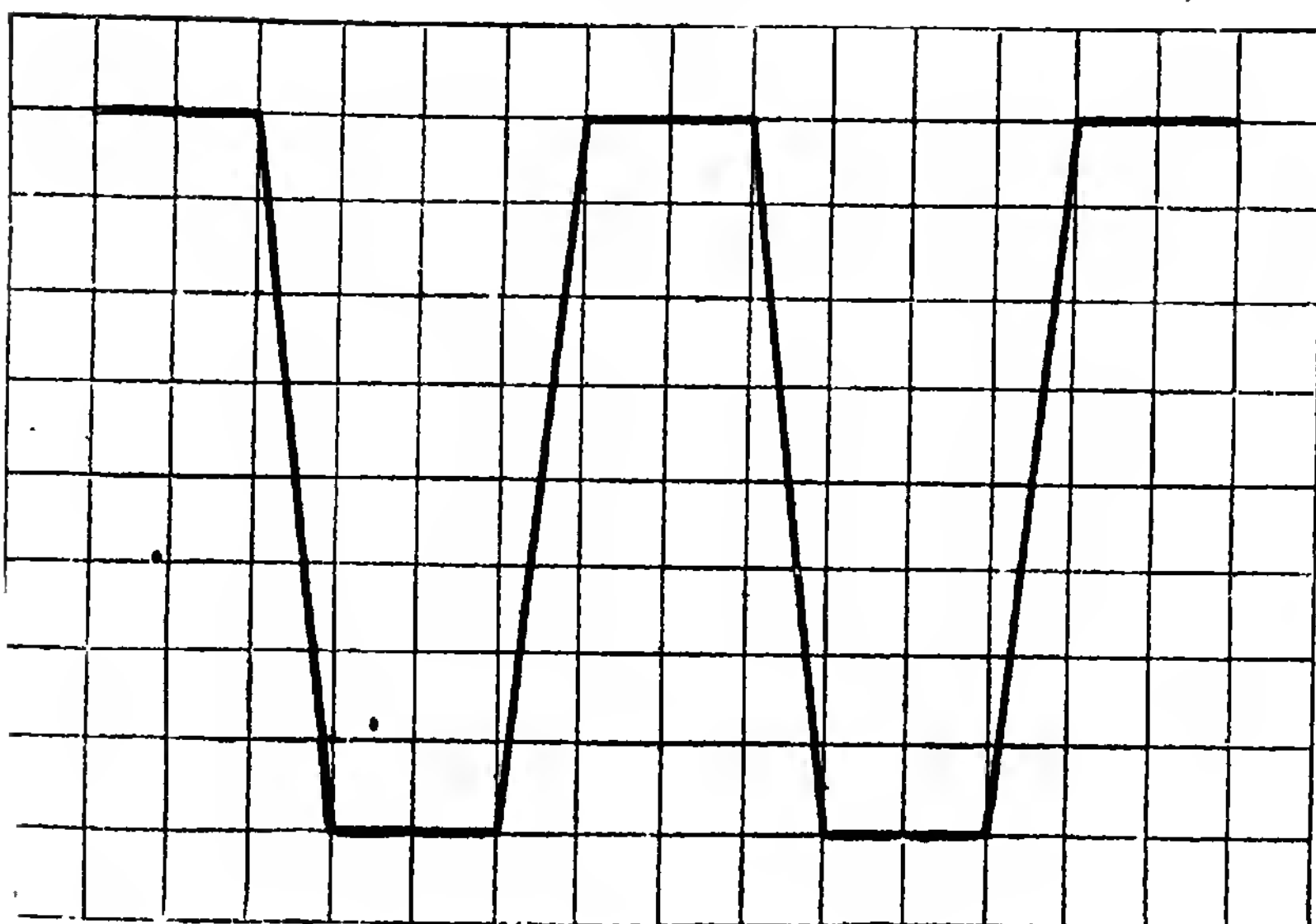


FIG. 2.



**Exercise XII.****WIRE MODELLING.**

**MATERIALS.**—*Wire 17" long (or coil from which to cut lengths) ; scissors ; rule ; squared paper ; pencil.*

Draw (with ruler) on squared paper a square with  $2\frac{1}{2}$  inches (ten small squares) side.

Draw also a triangle (equilateral), first ruling line eight small squares long, and joining each end of this line with point opposite middle of line and seven squares distant.

Calculate length of wire required for square similar to drawing, allow half-inch over, and cut off length from coil.

Bend aside the extra half-inch (to be used for holding or fastening) ; estimate middle point of remaining piece ; test, correct, and bend sharply there at right angles.

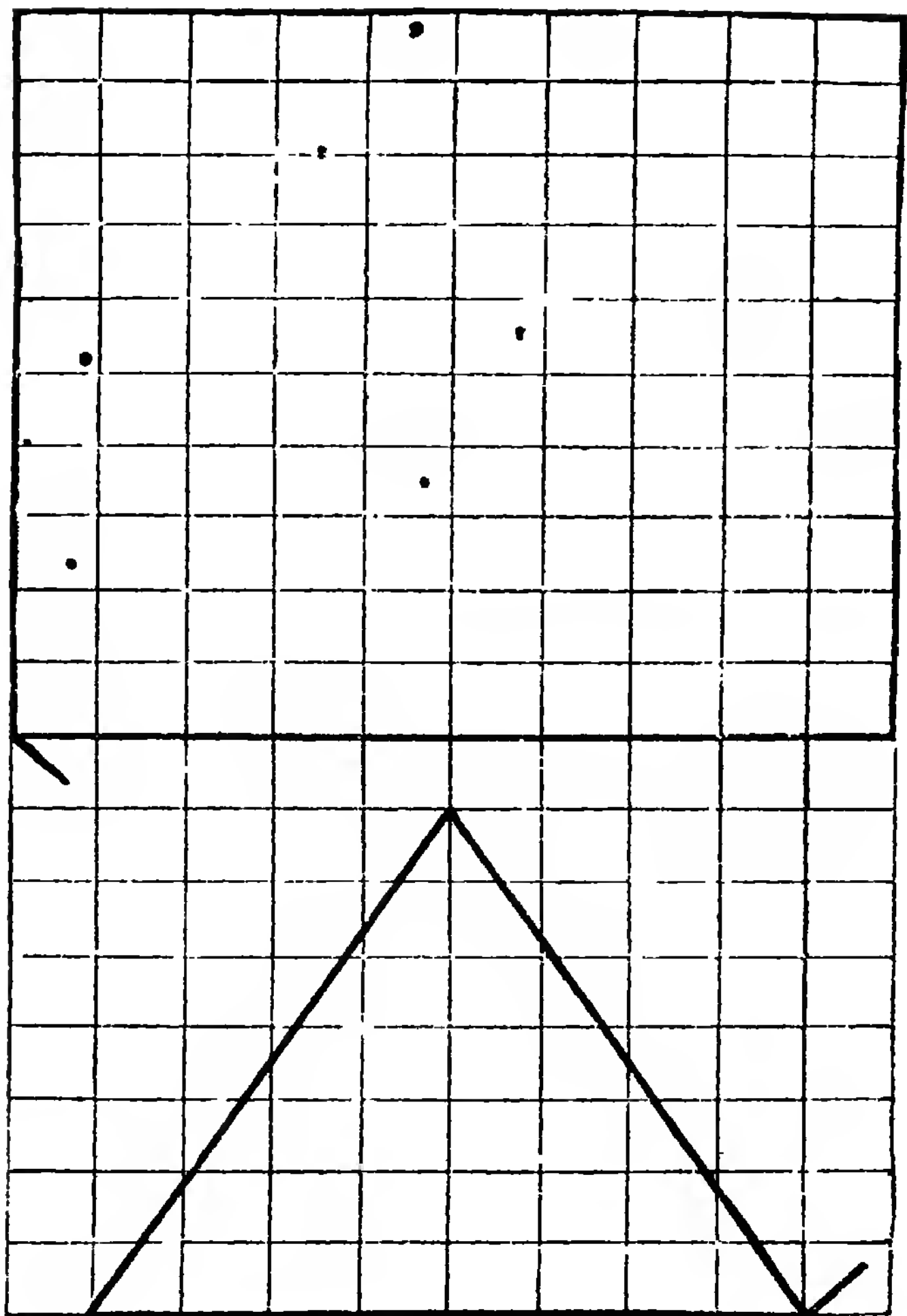
Estimate middle point of each half, test, correct, and bend sharply there at right angles to complete square.

Hold square by extra piece for inspection (or bend latter piece outwards, so as to enable square to stand upright alone).

Calculate length of wire required for triangle similar to drawing, allow half-inch over, and cut piece to proper length.

Bend aside extra half-inch ; estimate points at which wire must be bent ; test, correct, and bend to form triangle.

Compare wire models with drawings.



**Exercise XIII.****PAPER CUTTING AND MOUNTING (PLATE III.).**

**MATERIALS.**—*Large white paper square ; coloured gummed paper square (each pair of children having different colours which harmonize) ; ruler ; pencil ; scissors ; damp sponge.*

Fold square accurately along middle line, bringing opposite edges together, and crease.

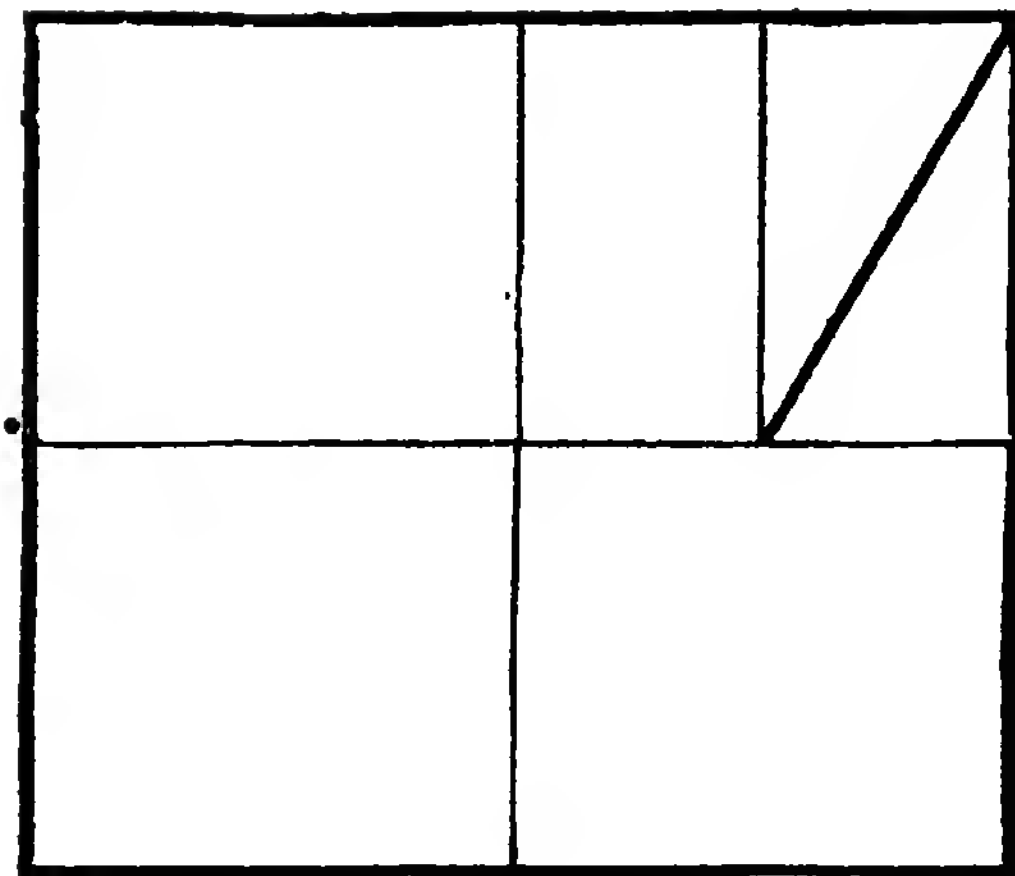
Open out square and cut carefully along middle line. (The ruling and cutting must be very carefully done to get a good result.)

Change one piece with neighbour for piece of another colour.

Double each piece to get from it two small squares (see figure) ; then each square to get two equal oblongs.

Rule one diagonal on each oblong (taking care to rule same one in each case), and cut carefully along ruled line.

Mount the triangles (of the two colours alternately) with their sharp angles meeting in centre of large paper square (Plate iii. Fig. 1).



**Exercise XIV.****CLAY MODELLING.**

**MATERIALS** — *Moist clay (enough to form ball about 2" diameter) ; modelling board ; small square wooden block ; damp sponge. (See Note G, p. 6.)*

Roll clay on board, and with both hands, to form sphere.

Roll clay sphere on board with block to form short cylinder with flat ends, and set upright on one end.

Roll cylinder to form pointer-like rod tapering to blunt point at one end.

Roll out again to uniformly thick rod, flatten and mould into shape of figure 6.

FIG. 1.

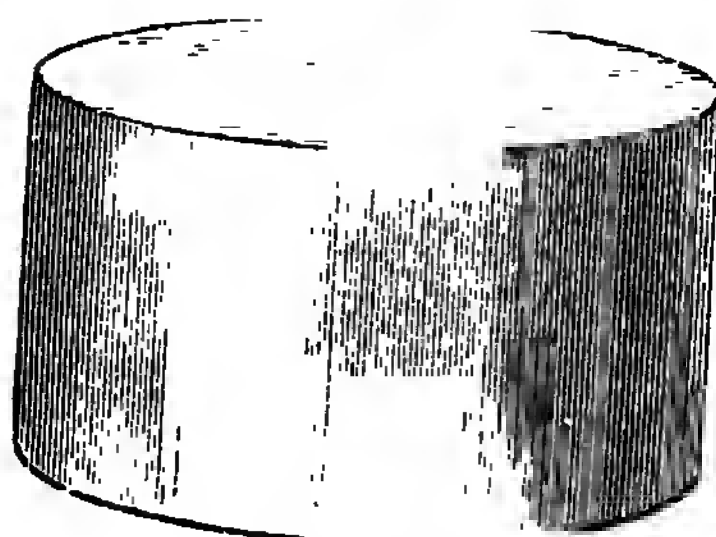


FIG. 2.

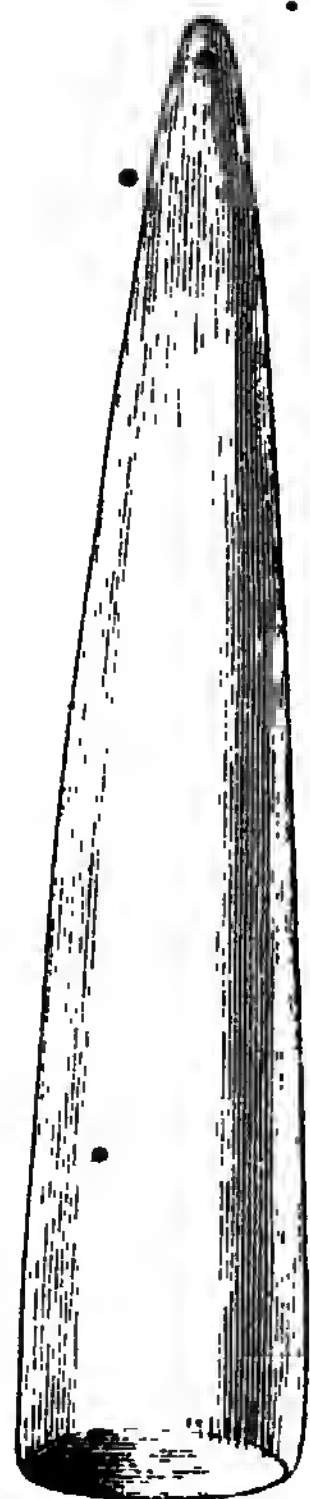
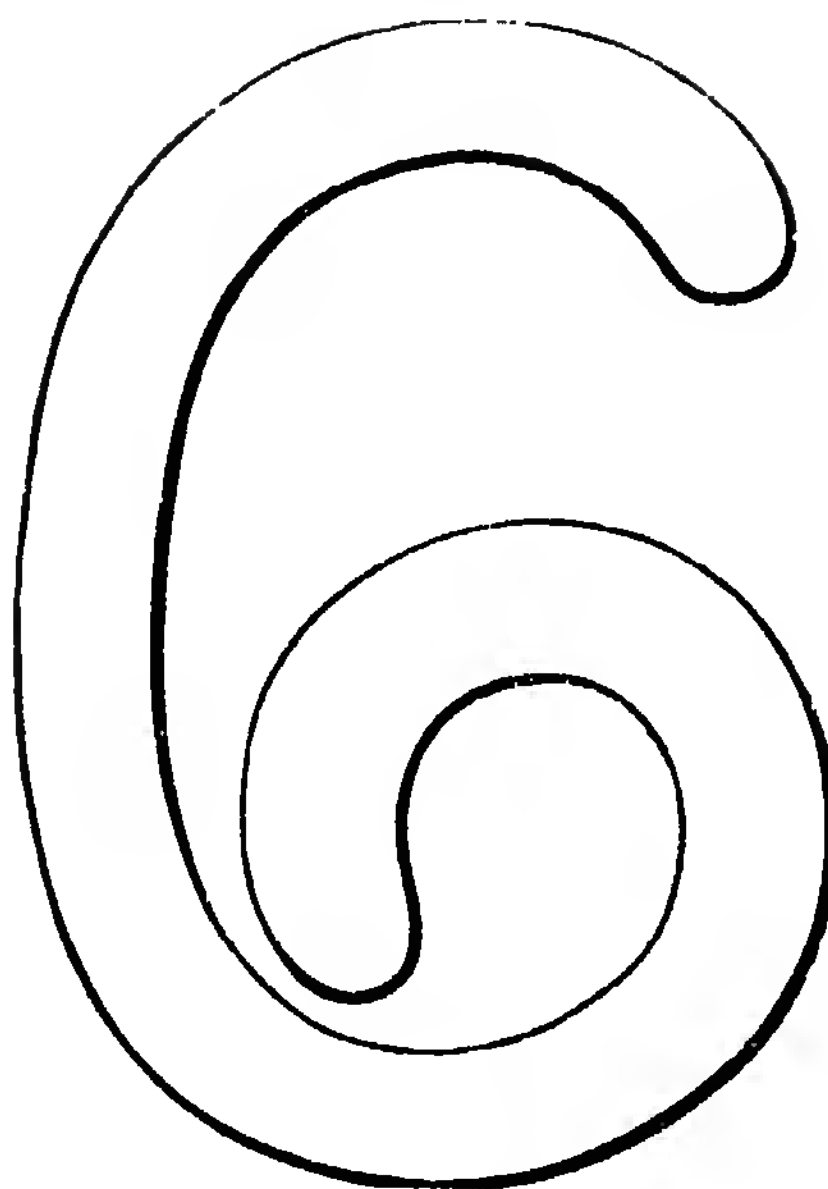


FIG. 3.





**Exercise XV.**

## CLAY MODELLING.

MATERIALS.—*Moist clay ; modelling board ; modelling tool ; damp sponge.*  
(See Note II, p. 7.)

Roll clay into cylinder ; cut cylinder into three equal pieces.

Roll each piece into form of sphere ; compare sizes of spheres.

Model one piece into shape of solid hemisphere (like half-orange).

Model second piece into hemispherical cup.

Children model third into any form they please.



**Exercise XVI.**

## CLAY MODELLING.

MATERIALS.—*Moist clay ; modelling board ; modelling tool ; damp sponge.*  
[*Egg and, if possible, acorn as models.*]

Divide clay into two equal-sized pieces, and roll each into sphere.

Model one piece into shape of egg. (Examine egg to note how its shape differs from that of sphere.)

Make other piece into shape of cup to fit larger end of egg.

Place egg in cup and slightly alter its form to represent an acorn (copying from actual specimen or from drawing).

Mark outside of cup (by pressing end of modelling tool into it) to represent rough surface of acorn-cup.

FIG. 1.

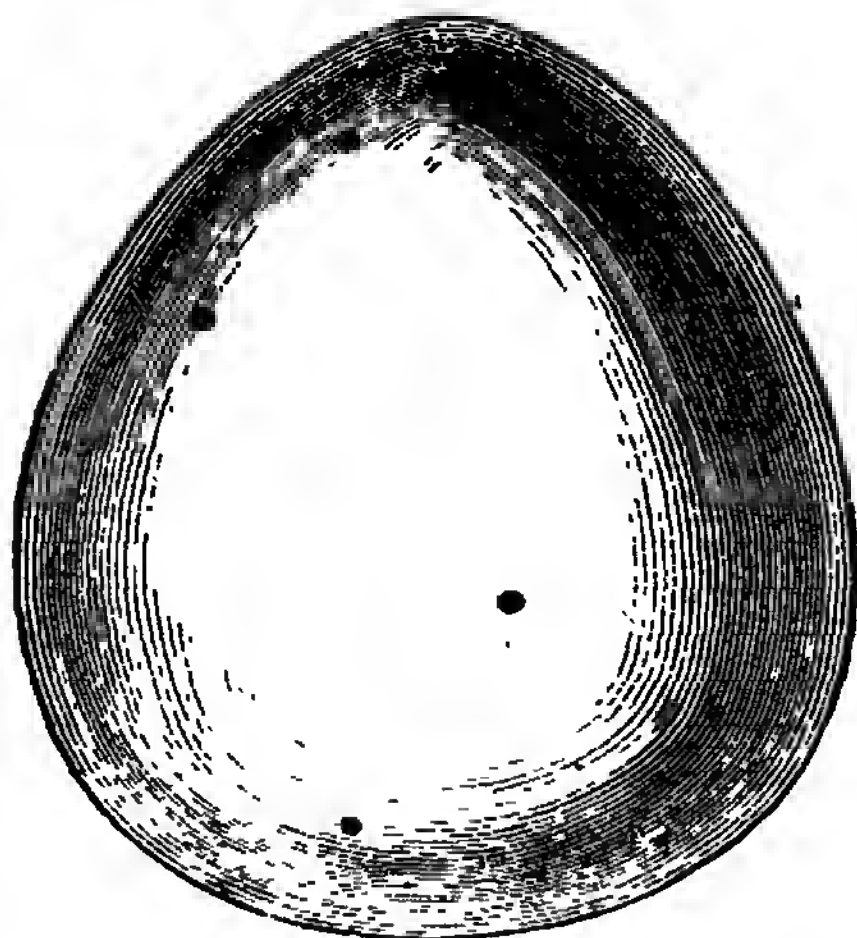
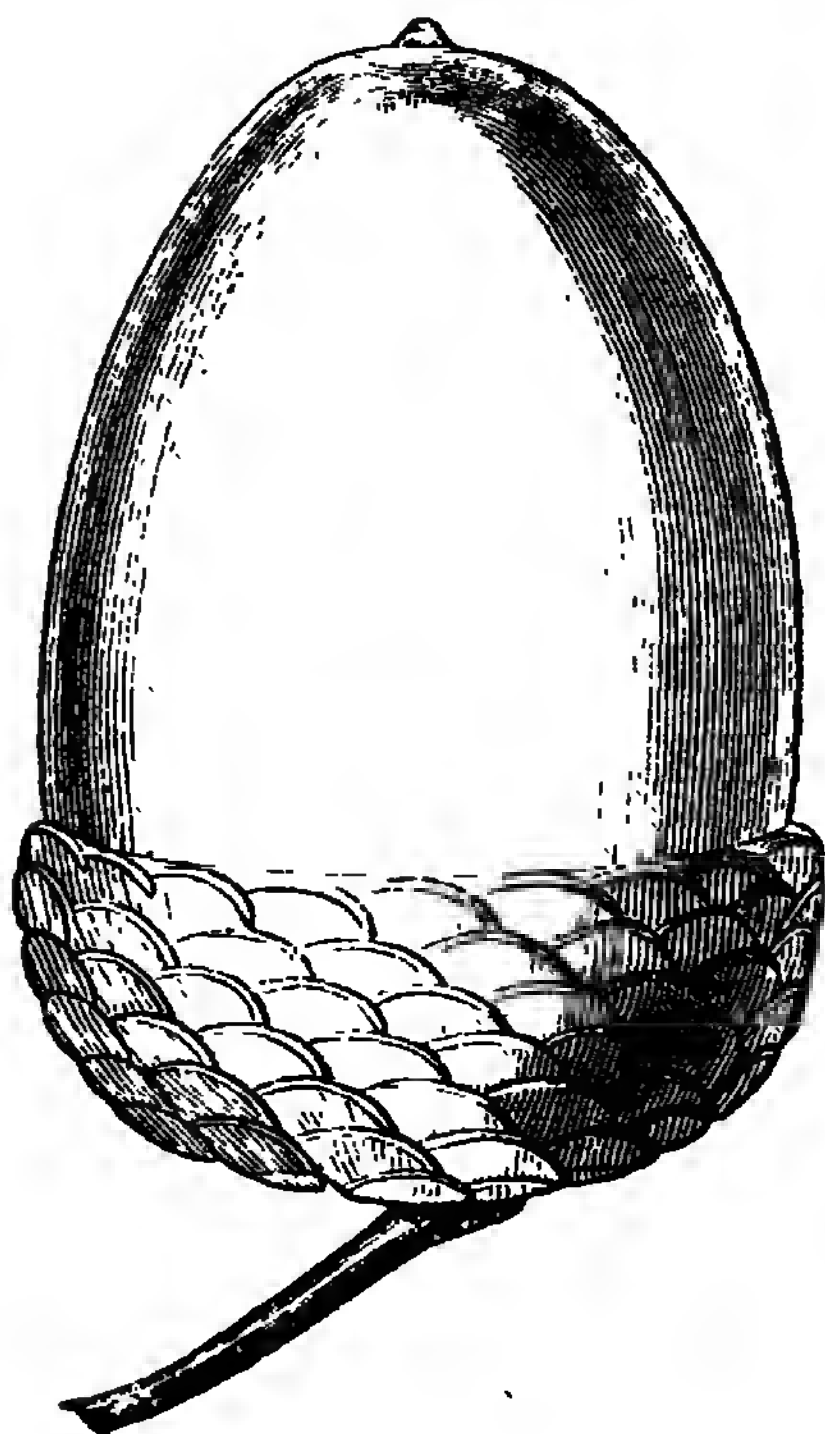


FIG. 2.



**Exercise XVII.****DRAWING AND PAPER-CUTTING.**

**MATERIALS.**—*Large white paper square; model circle; model square; rule, lead pencil; scissors.*

Rule two lines joining middle points of opposite sides of paper square.

Lay model circle symmetrically in centre of large square and faintly trace its outline.

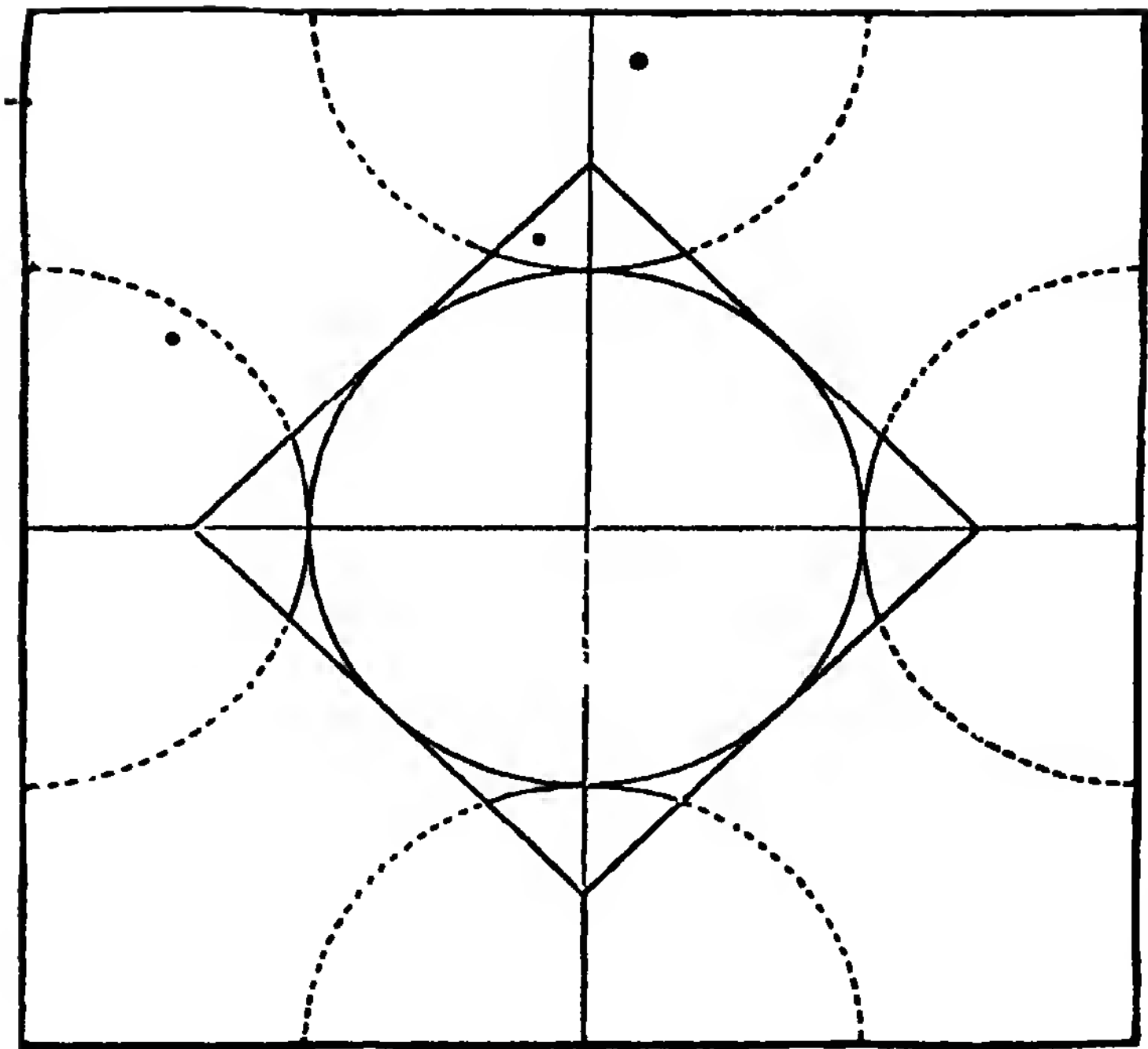
Lay model square symmetrically, with corners on ruled lines, and trace its outline. (Note that, if circle previously laid correctly, sides of square should just touch it; if not correct, lay again inside square and trace outline strongly.)

Lay model circle symmetrically over each edge of square in succession, touching outline of circle previously drawn, and trace the four semicircles.

Cut carefully from edges of paper square along curved lines to meet sides of inner square (as dotted in figure).

Fold and crease the corner pieces along sides of inner square, and fold down over each other.

Fold down semicircles (as far as they are cut) in opposite direction to corner pieces (*i.e.* on to the other side of the large square).



**Exercise XVIII.****DRAWING AND COLOURING.**

**MATERIALS.**—*Large white paper square ; model circle ; rule ; lead pencil ; crayons (with holders and stumps).*

Rule faintly the diagonals of the square.

Rule faintly border lines at equal distances (about  $\frac{1}{4}$ " ) from each edge of square, without measurement.

Rule faintly other lines parallel to last, and about  $\frac{3}{4}$ " distant from each edge of square.

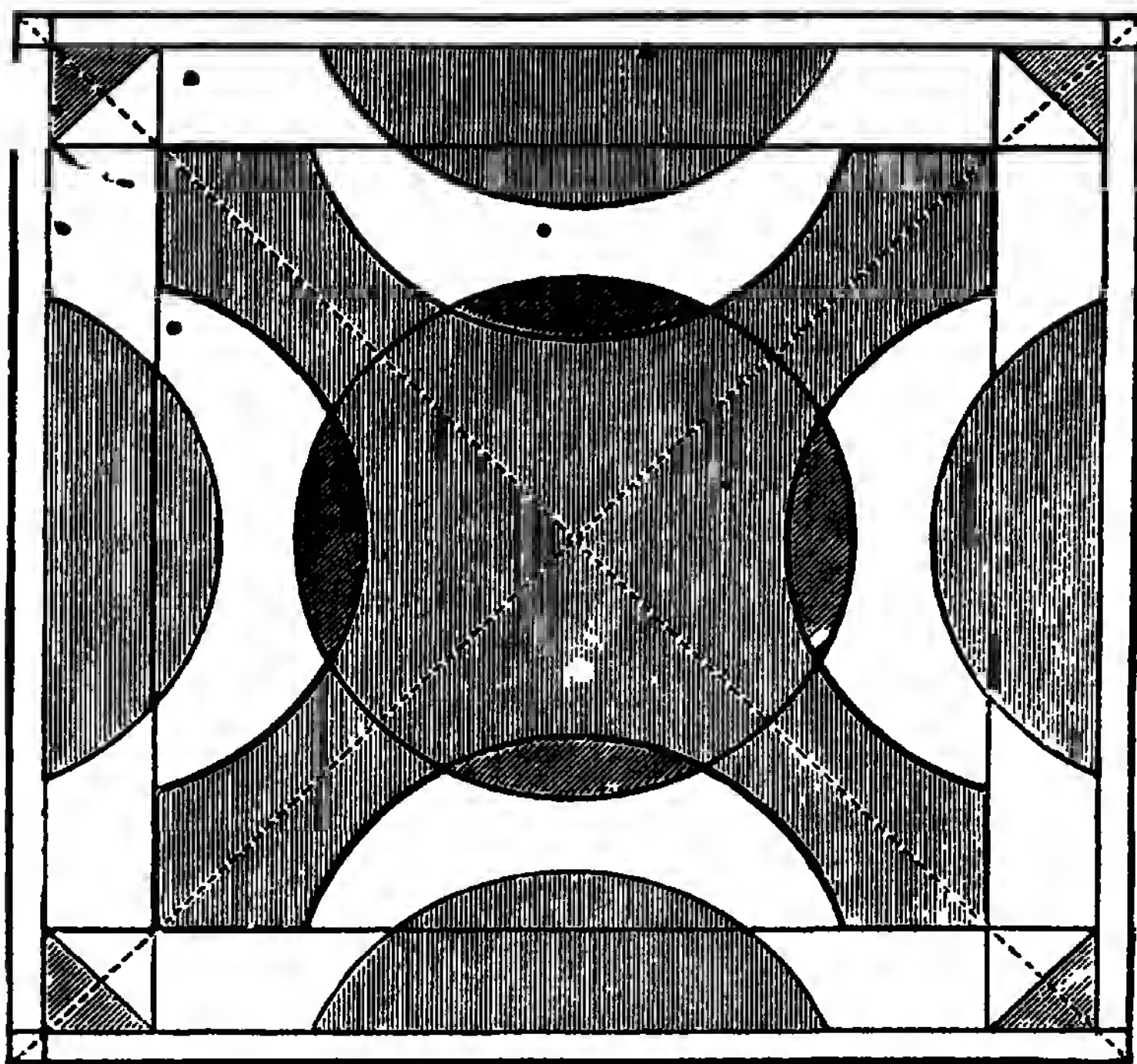
Lay model circle symmetrically in centre of square and trace outline.

Lay model circle symmetrically to form nearly a semicircle on each side of outer ruled square, and nearly but not quite touching inner circle.

Mark points on sides of inner square, at equal distances (about  $\frac{1}{2}$ " ) from corners, and lay model circle so as to trace arc joining pairs of points on same side (as in figure).

Draw one diagonal of small corner squares.

As a reward for careful drawing the children might be allowed, (in another lesson, if necessary), to colour the pattern with crayons of two different colours.





**Exercise XIX.****PAPER CUTTING AND MOUNTING (PLATE III.).**

**MATERIALS.**—*Large white paper square; two gummed 'paper squares' of different colours; model circle; pencil; scissors; damp sponge.*

Carefully trace outline of model circle on the back of the darker coloured square, and cut out.

At the back of the other coloured square, mark points on sides at equal distances (about  $\frac{1}{2}$ " ) from each corner.

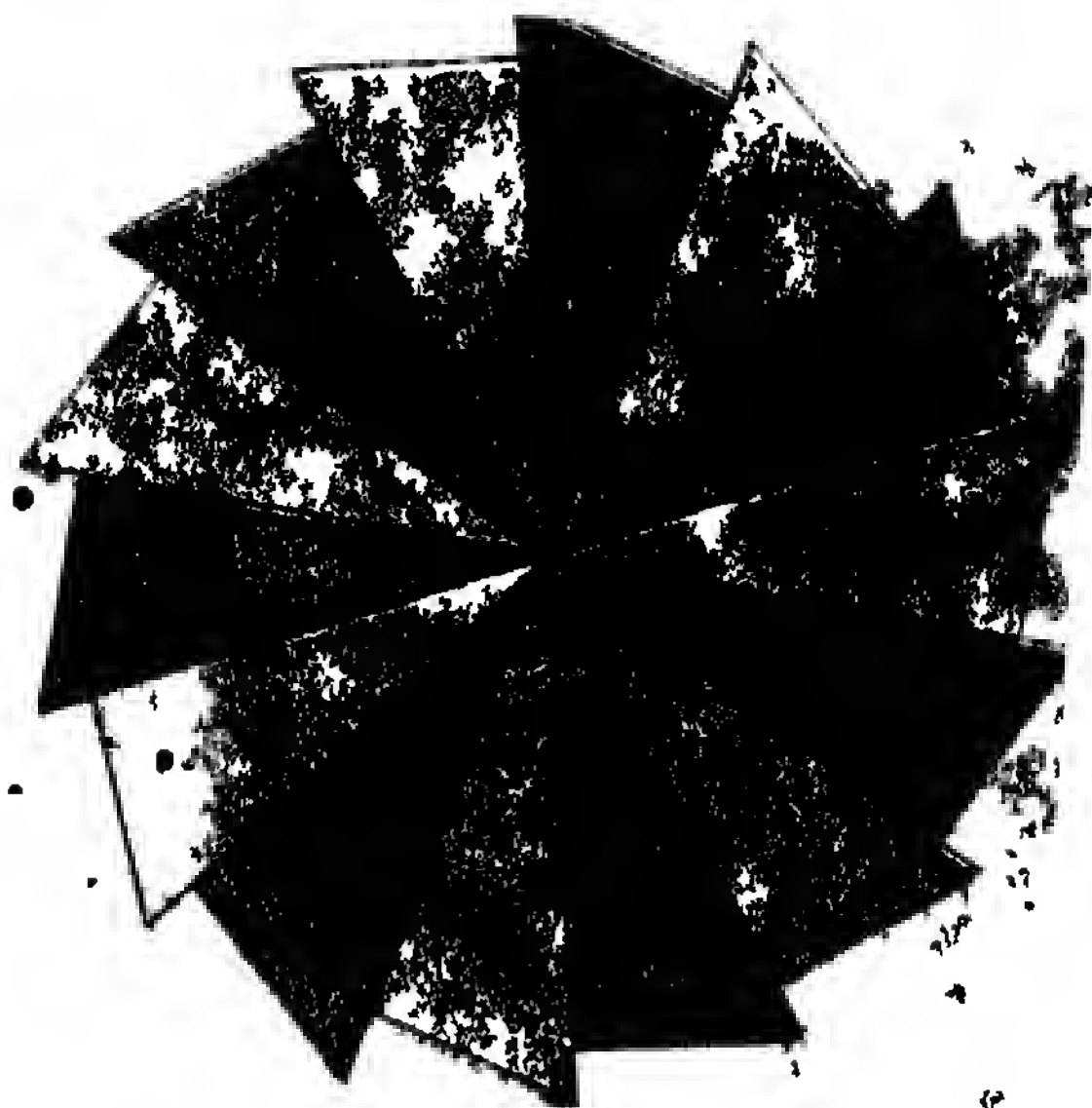
Lay model circle and trace arcs joining pairs of points on each side of square (as in last exercise).

Carefully cut out the curved pieces so marked.

From corners of first coloured square, cut off equal-sized corner pieces (as marked in last exercise).

Lay paper circle symmetrically (by estimation) in centre of large white square; lay the cross symmetrically over circle diagonally in square; and lay semicircles and corner pieces, so as to form altogether a pattern similar to that drawn and coloured in last exercise.

Mount the pieces in this position (Plate iii. Fig. 2).







**Exercise XX.**

## ENVELOPE FOLDING.

**MATERIALS.**—*Squared paper ; pencil ; ruler ; scissors. [Envelope opened out as pattern.]*

(*The teacher should show the class an envelope opened out, —note the number and relative sizes of its various parts, e.g. flaps fold to just beyond middle point of face, etc.*)

Mark a point four squares from top of squared paper, and five squares from left side ; and from point rule along the horizontal line a line nine squares long.

Rule corresponding line six squares lower down, and join ends of two lines to form rectangle.

Calculate approximately the size of flaps required to fold over rectangle rather more than half-way.

Mark points opposite middle points of ends and five squares distant, and rule lines to corners of rectangle (Fig. 1).

Mark points opposite middle points of long sides, upper one four squares distant, lower one three squares and a half distant, and rule faint lines to corners of rectangle (dotted lines in Fig. 1). The advantage of having broad ends to the side flaps might be shown on the pattern envelope, and the ends in the drawing be made two squares wide (Fig. 1).

Cut out the form with scissors.

Fold carefully along the lines to form envelope.

Fold small strip of paper, and enclose in envelope.

**NOTE.**—It would be well to repeat this exercise, leaving the children as much as possible to themselves, or giving them the envelope made on the previous occasion ; and when they have ruled the lines, let them modify them as shown in Fig. 2.

FIG. 1.

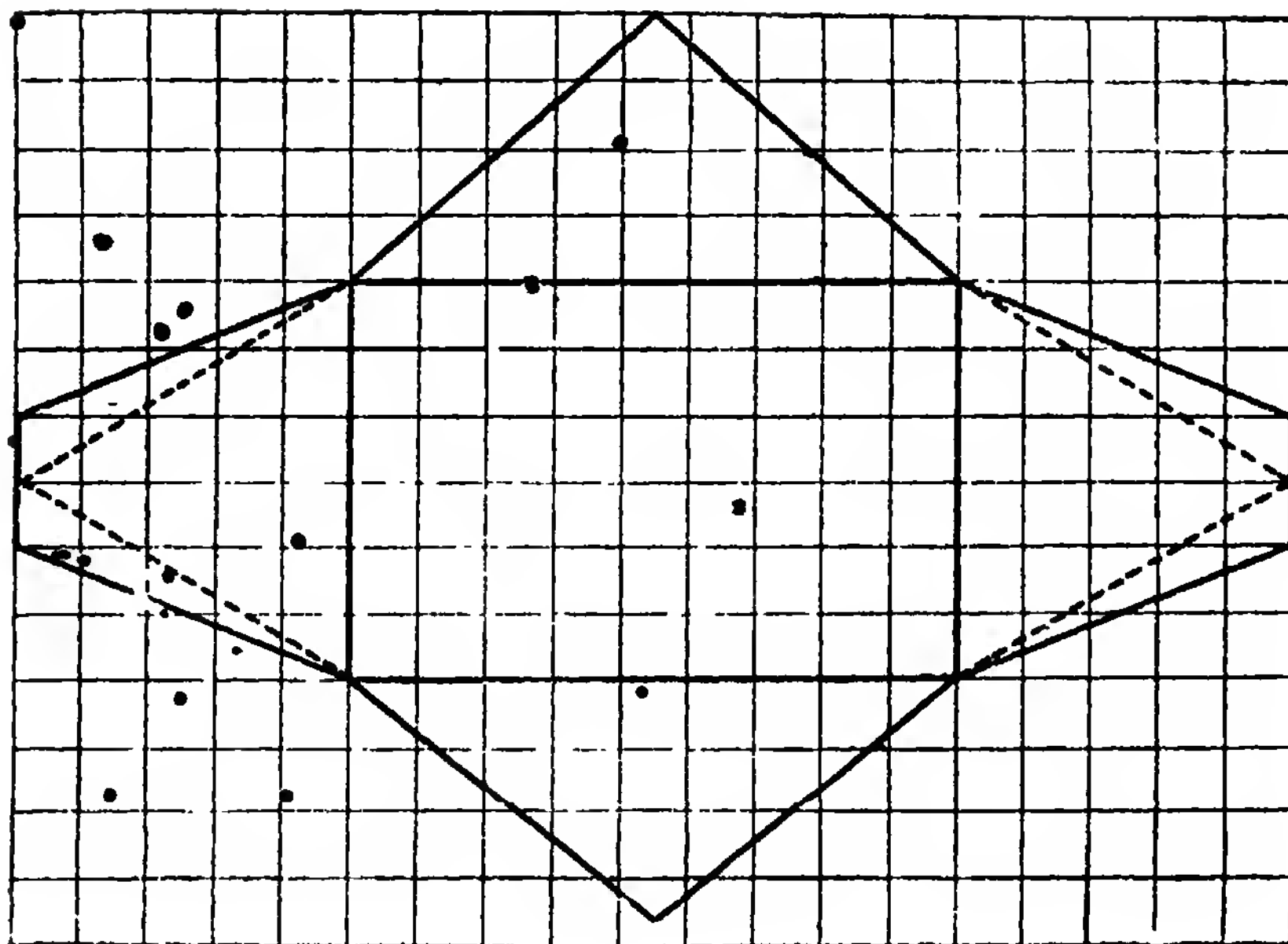
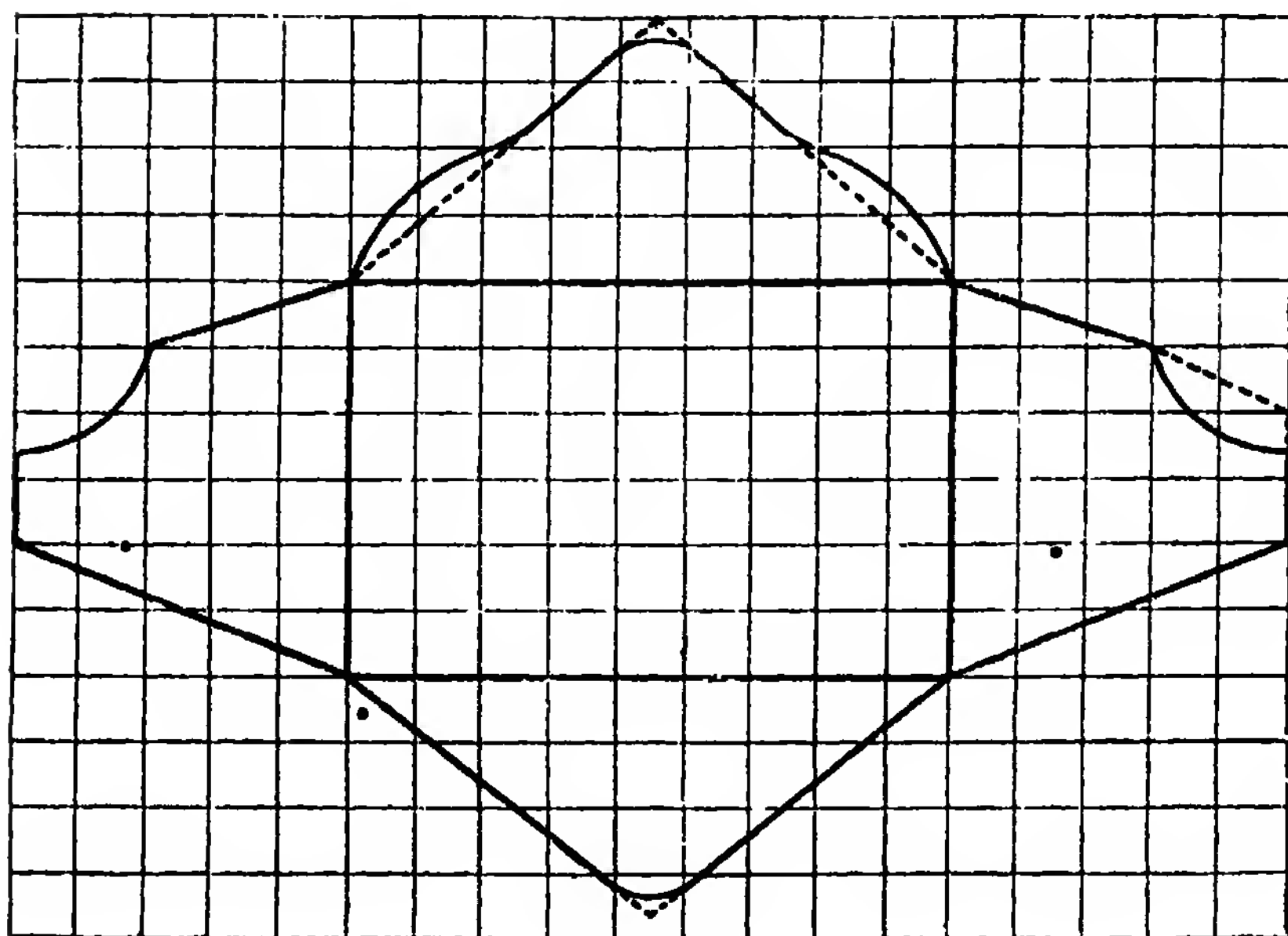


FIG. 2.



**Exercise XXI.****ENVELOPE MAKING.**

**MATERIALS.**—*Large white paper square ; pencil ; rule ; scissors. [Oblong paper envelope (Fig. 1) opening at one end as pattern, or sketch of same on blackboard ; gum and brush.]*

*(The teacher should show pattern envelope opened out, and note number, shape, and relative sizes of flaps, etc.)*

Rule line faintly down middle of square.

Fold parts on each side of middle line so as to slightly overlap each other on middle line, and crease down.

Fold down top and bottom sides of square to form small bottom flap and larger top flap, and crease.

Cut out corner pieces (Fig. 2), and fold down flaps to make envelope or bag. (Note that the edges of the flaps are somewhat in each other's way.)

Rule line from middle point of top edge of upper flap to middle points of sides, and cut off corner pieces.

Rule lines (as dotted in figure), bevelling off edges, and cut along line with scissors.

Fold envelope again.

Gum down those which are well made.

FIG. 1.

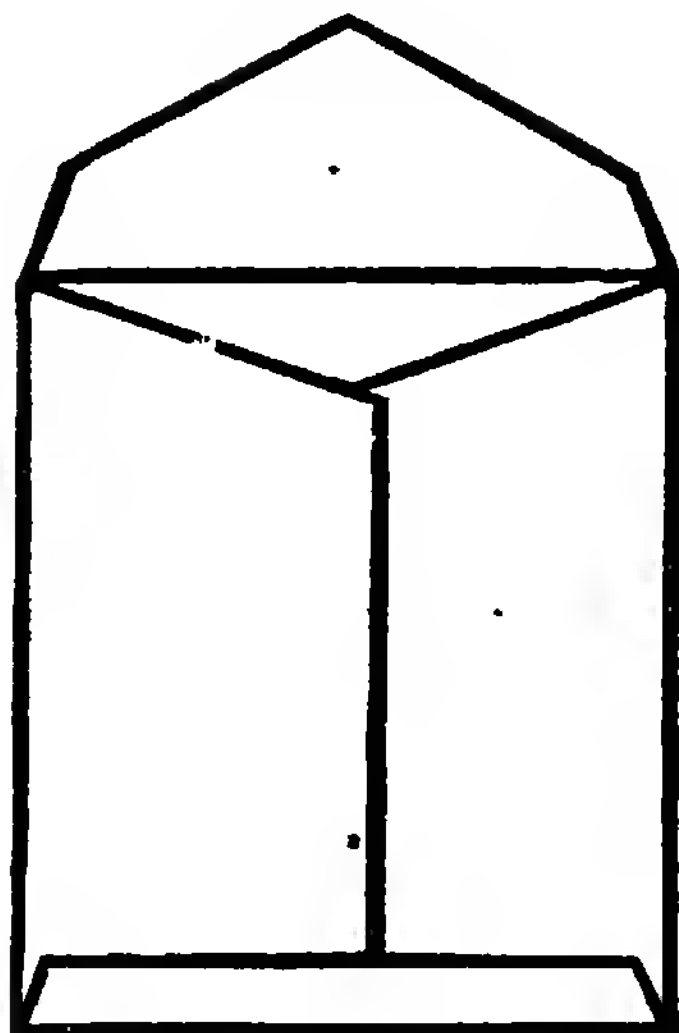
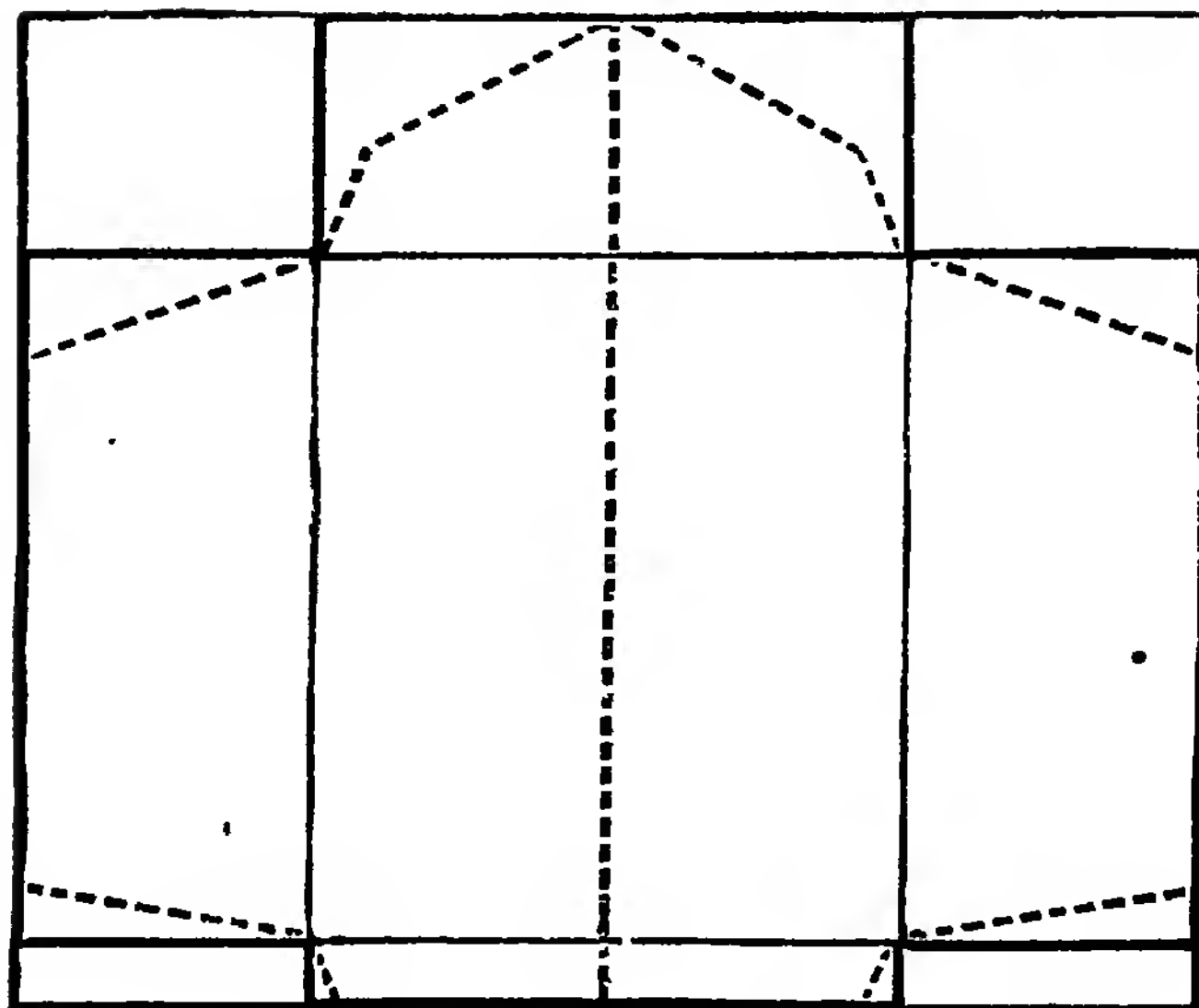


FIG. 2.





**Exercise XXII.**

## CLAY MODELLING.

MATERIALS.—*Moist clay ; modelling board ; modelling tool ; small square wooden block ; damp sponge.*

*(Set up drawing models, or else make a sketch on the board of the objects to be modelled.)*

Divide clay into two equal-sized pieces.

Model one piece into square slab (about 2" in the side), working it with wooden block and tool, and being careful to make the angles sharp.

Roll other piece into cylinder about 2" long.

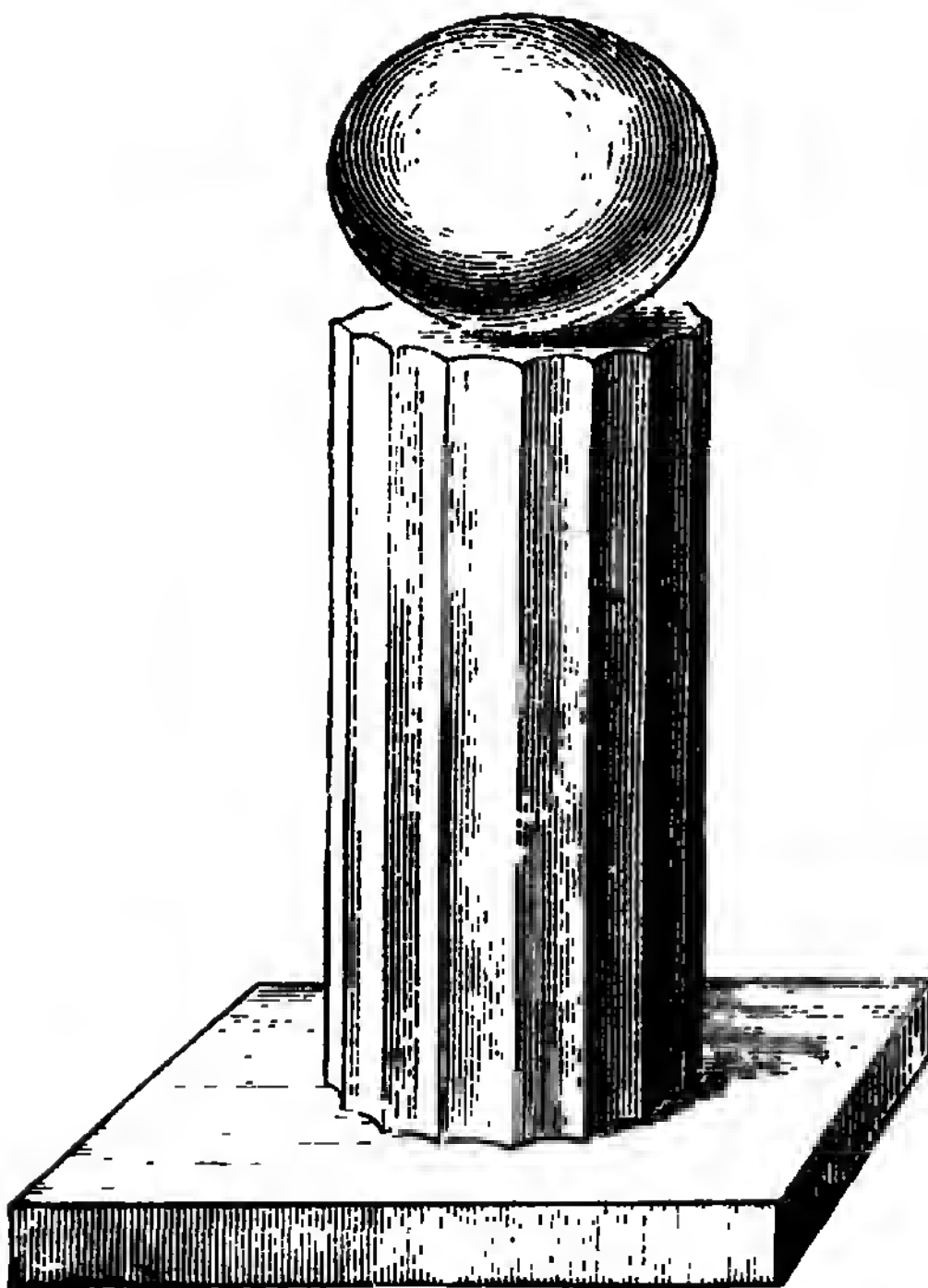
Set cylinder upright on centre of slab.

Cut off about one quarter of cylinder, and roll the piece to form a sphere.

Roll out the cylinder to about the same height as before.

Mount the cylinder on the square, and the sphere on the cylinder.

The sides of the cylinder might be fluted with vertical parallel grooves by means of the tool.



**Exercise XXIII.****CLAY MODELLING.**

**MATERIALS.**—*Moist clay ; modelling board ; square wooden block ; modelling tool ; damp sponge.*

*(Set in front of class a large vase, or bottle with straight sides, as the object to be modelled.)*

Roll out the clay to form a short cylinder with flat ends, and set it upright on the wooden block.

Model cylinder to shape of bottle or vase shown.

FIG. 1.

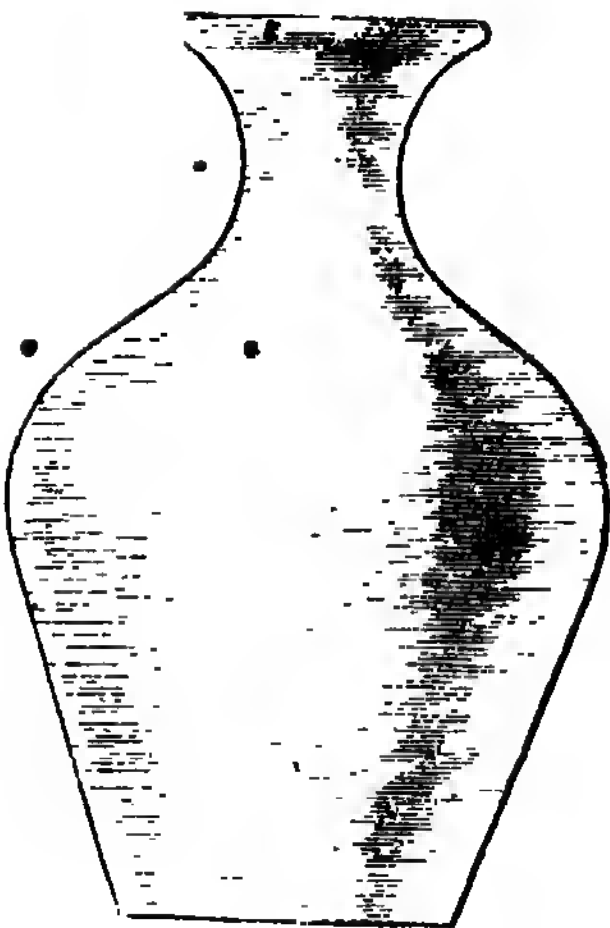


FIG. 2.

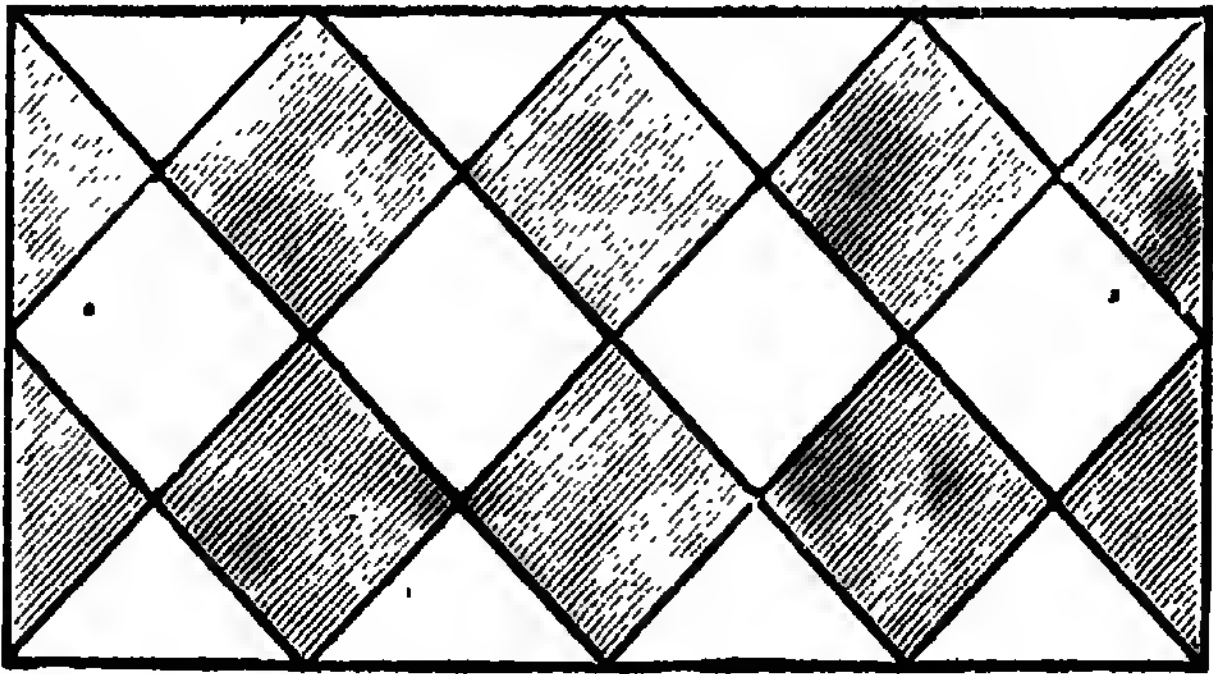
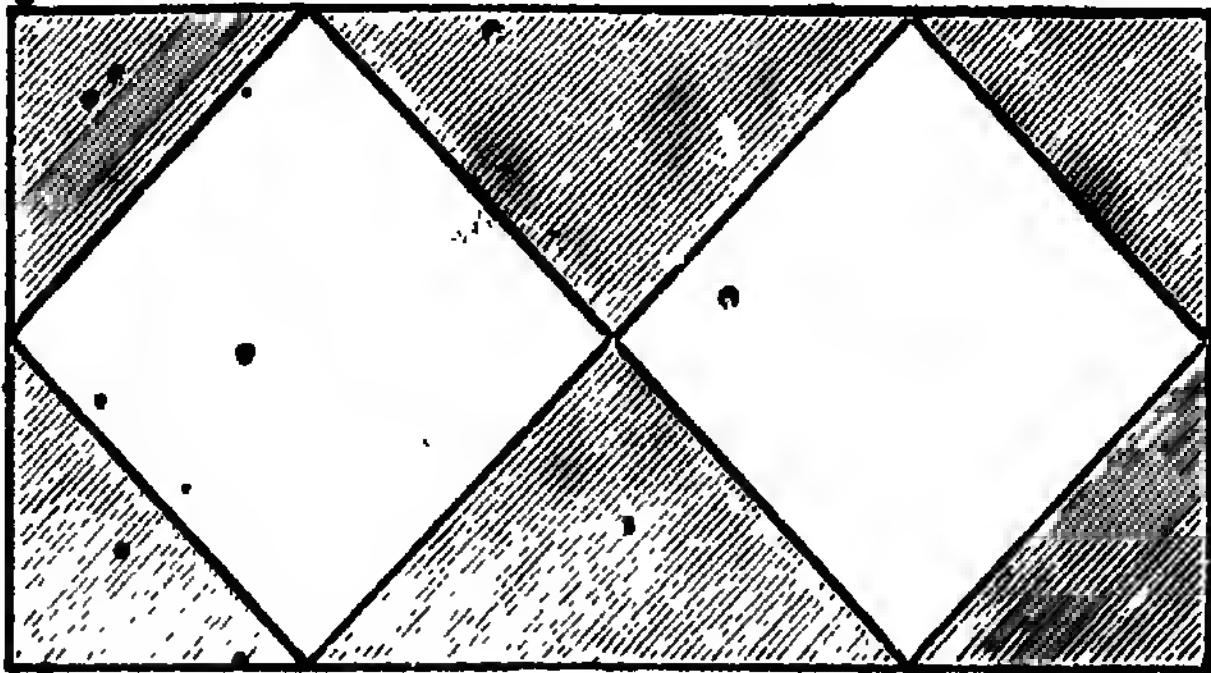


**Exercise XXIV.**

## DRAWING AND COLOURING.

**MATERIALS.**—*Plain white card ( $4\frac{1}{2}$ "  $\times$  3") ; rule · pencil ; crayons with holders and stumps.*

Rule lines at distance of quarter-inch from each edge of card.  
Rule faint lines inside first, and at distance of half-inch from them, so as to make an oblong having sides 3" by  $1\frac{1}{2}$ ".  
Divide sides of oblong by points at distance of  $\frac{3}{4}$ " apart.  
Draw lines faintly, either as in Fig. 1 or Fig. 2.  
Colour with crayons of two colours, to form pattern. (The crayons will not "take" very well on the comparatively smooth surface of the card, but it is well that the children should find this out by actual experience.)  
Rule in strongly the lines bordering the colours.  
Each card should have the child's name written on it, and be kept for the next exercise.



**Exercise XXV.****ENVELOPE MAKING.**

**MATERIALS.**—*Piece of paper 8" × 6" (a leaf of an ordinary exercise-book might be used) ; card from last exercise ; scissors ; ruler ; pencil.*

Lay card symmetrically in middle of paper to indicate where to fold latter to make an envelope to hold the card.

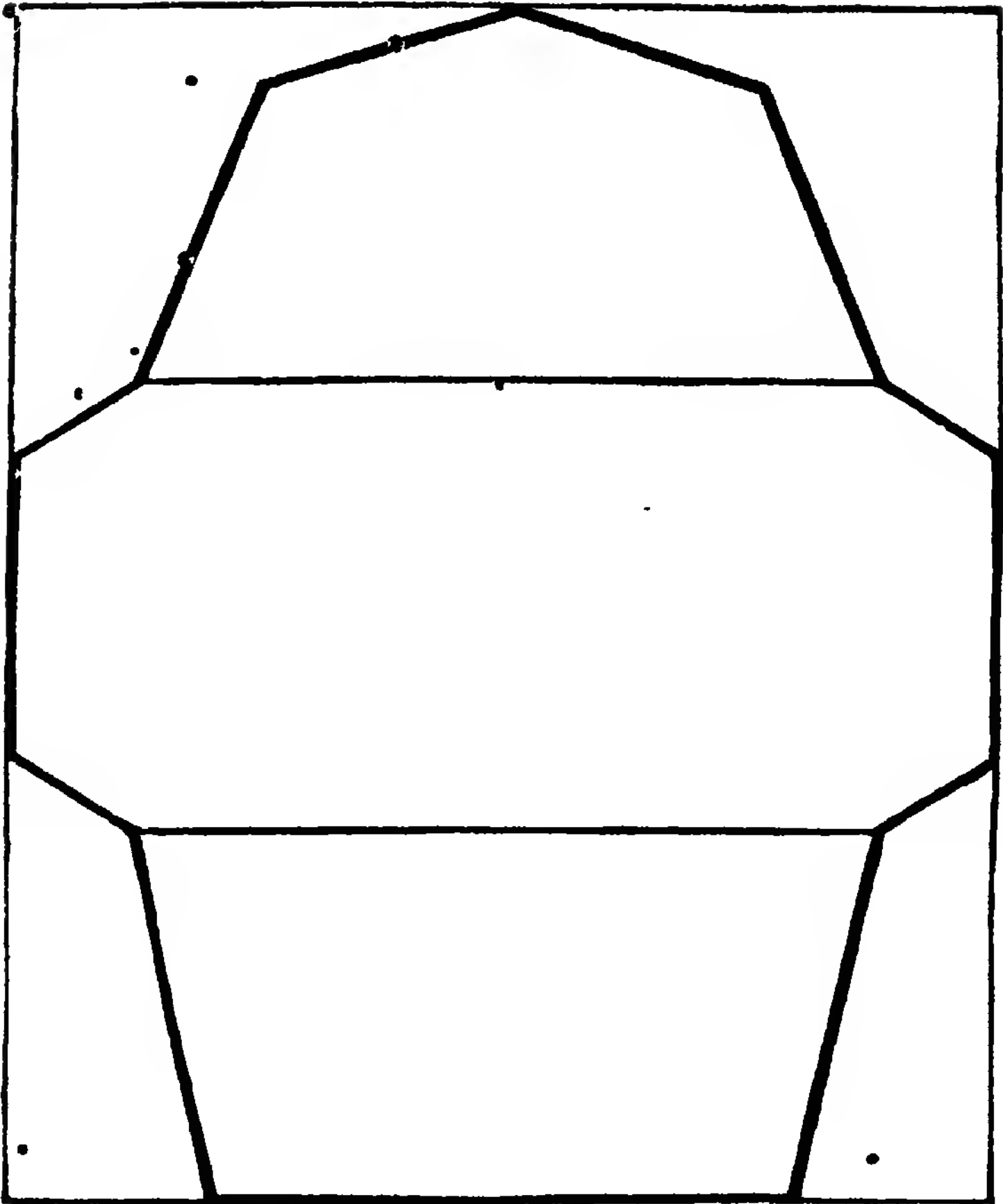
Rule lines parallel to and nearly touching edges of card.

Fold paper along those lines, and crease well.

[The rest of the exercise should be left almost entirely to the children themselves, to work out independently—suggesting to them, if necessary, to slope the edges of the flaps as in a previous exercise.

It will be observed that the side flaps in this case are not large enough to meet and overlap each other, as in the envelope previously made ; the top and bottom flaps may therefore be made longer in proportion.

Well-shaped and folded envelopes might be gummed and fastened, the card enclosed, and the name of the child and the date written on the back.]





**Exercise XXVI.****WIRE MODELLING.**

**MATERIALS.**—*Wire, about 12" long; rule; white paper square.*

Measure length of wire, after straightening it out.

Draw wire several times between fingers (or over edge of slate frame) to give it a curved form.

Twist the two ends of the wire together (using as little wire as possible for the twist).

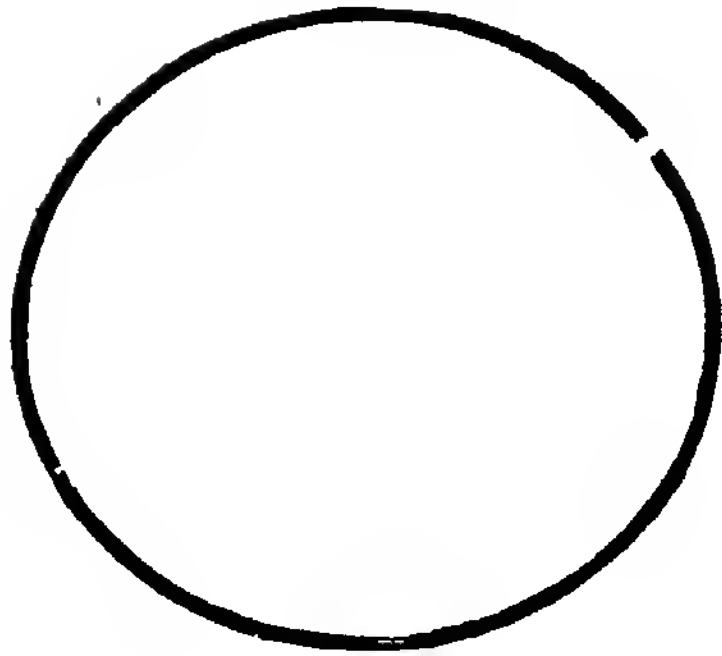
Form the wire into as accurate a circle as possible, making it to lie flat on the desk. (A piece of white paper might be given to lay the wire on so that the shape may be better seen.)

Measure various diameters of the circle.

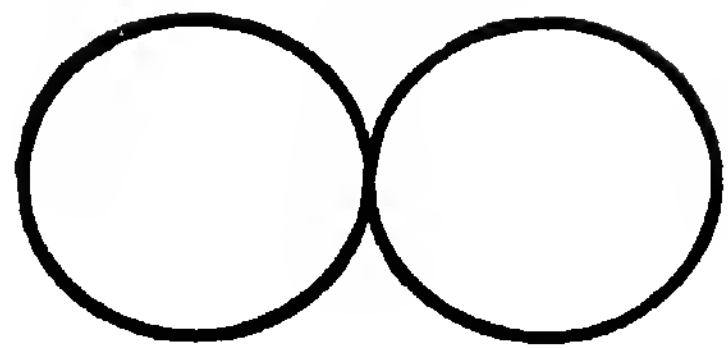
Press two opposite points of the circle together to meet and twist wire once there,—then form each part into a small circle, and make the figure so as to lie flat (Fig. 2).

Untwist the wire again (or use fresh piece), and model it into shape of leaf (according to copy on blackboard).

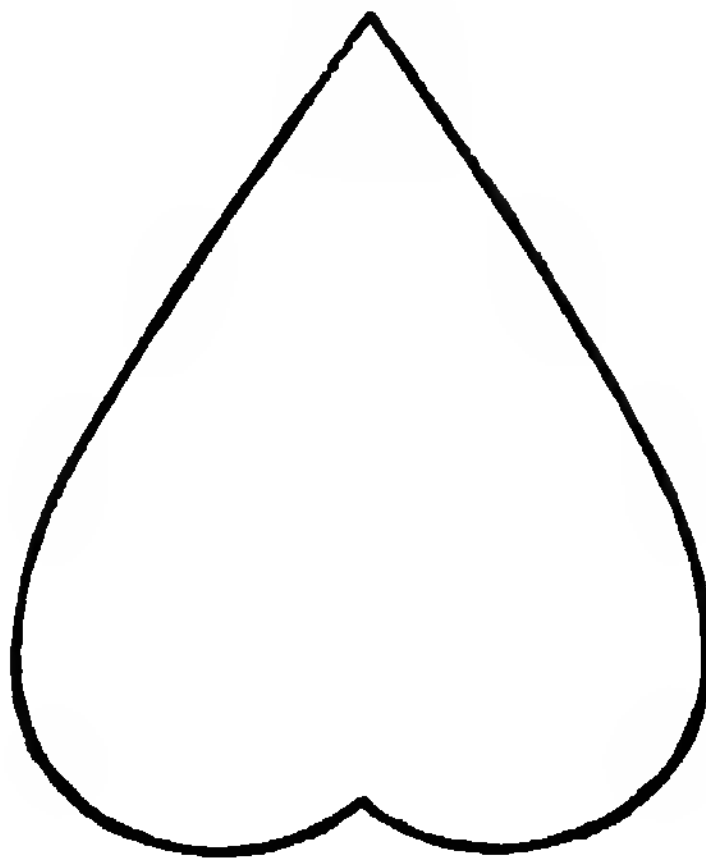
**FIG. 1.**



**FIG. 2.**



**FIG. 3.**



**Exercise XXVII.****DRAWING AND WIRE MODELLING.**

**MATERIALS.**—*Wire about 13" long; rule; pencil; squared paper.*

Draw in middle of squared paper a rectangle fourteen squares long by eight wide.

Mark points opposite middle point of long sides of rectangle and four squares distant.

Join these points to corners of rectangle to form hexagonal figure.

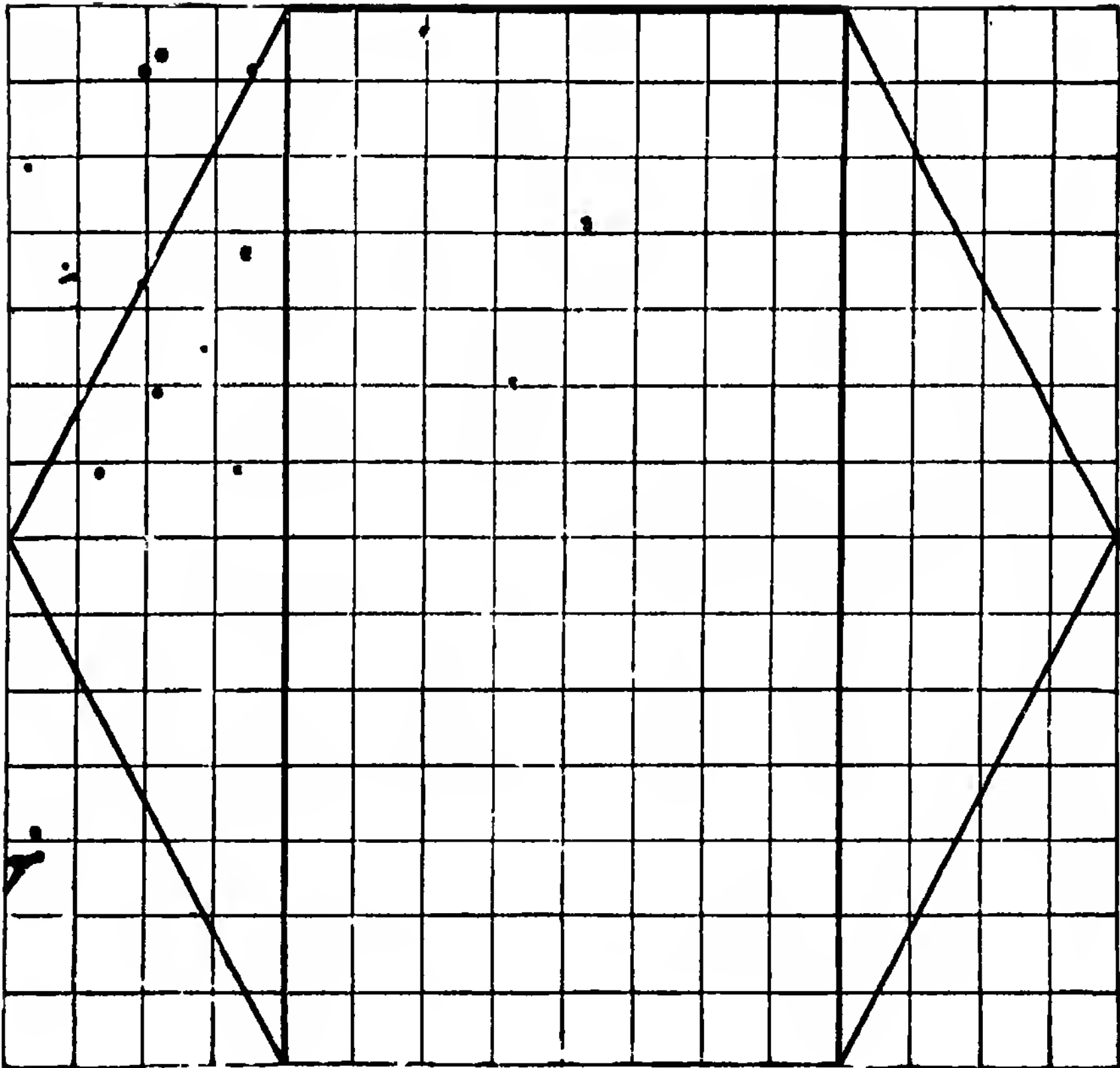
Measure sides of hexagon to prove that all are practically equal, and calculate the total length of wire required to form a similar figure.

Straighten out the wire, measure it, and bend aside the small piece not required for figure; or, better still, bend a small extra piece at each end.

Estimate lengths of wire for each side of hexagon in succession, test, correct, and bend at approximately correct angle at those points.

Twist the ends of the wire together and make the angles equal to those of drawing.

Lay the figure formed in wire over the drawing to test its accuracy.



**Exercise XXVIII.****DRAWING AND CUTTING LETTERS.**

**MATERIALS.**—*Squared paper ; ruler ; pencil ; scissors ; coloured gummed paper square ; damp sponge.*

(The teacher should first draw on the blackboard the plain capitals **I**, **T**, **N**.)

Draw on squared paper the capital letter **I**, seven squares long, one square wide.

Draw next a capital **T**, with the top bar five squares long and one wide ; and with a total height of seven squares.

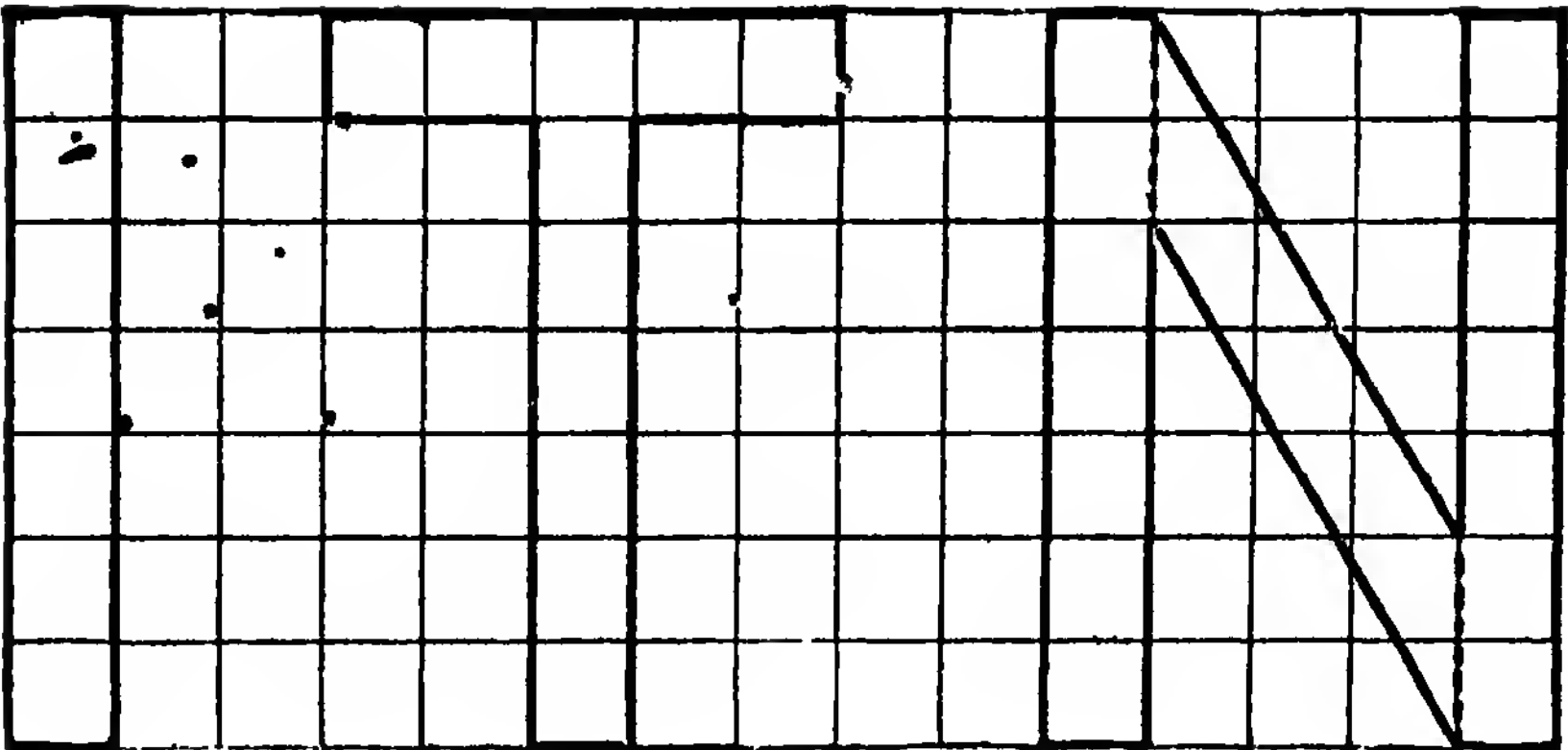
Draw capital **N** by first drawing two **I**'s equal in height to the other letters, parallel to each other, and with three clear squares between. Draw the diagonal lines from the end of one upright to a point two squares from the end of the other upright (see figure).

Cut out the outlined letters carefully with scissors.

Moisten each letter (in the above order) and fasten on gummed back of coloured square.

Cut out the letters as fastened on the coloured square. (If, as is probable, the **N** is fastened on so that when cut out it appears, as seen from the coloured side, as **M**, the plain side must be moistened and stuck down, and the letter again cut out.)

Lay the letters to form a word.



**Exercise XXIX.****DESCRIBING CIRCLES WITH STRINGS.**

**MATERIALS.**—*Large white paper square ; pencil ; modelling board (clean) ; drawing pin ; two pieces of string, one 6", other 5" ; rule.*

Rule faint lines joining middle points of opposite edges of square. Place drawing pin through paper at intersection of lines and press firmly into the board.

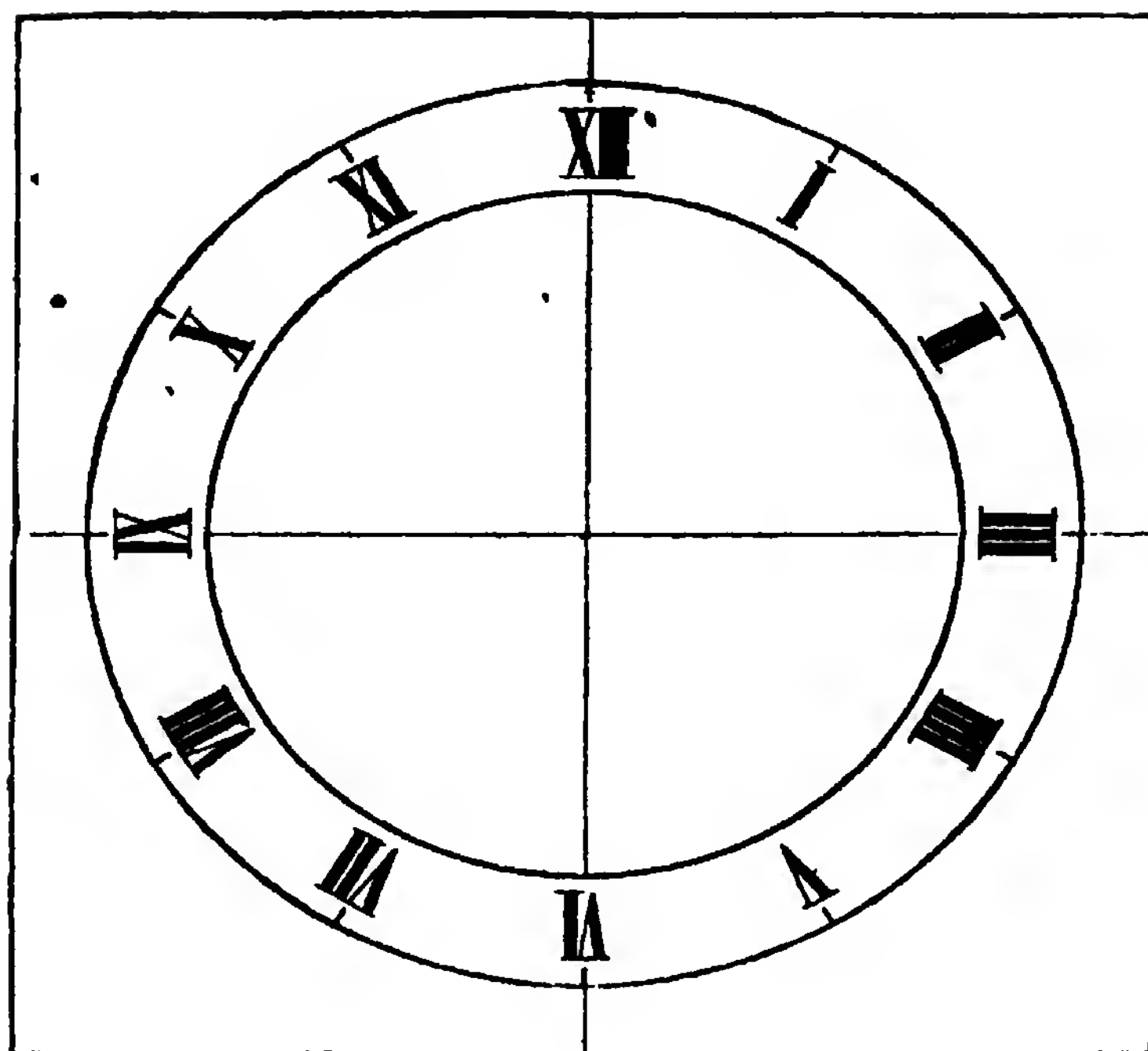
Make loops at ends of longer piece of string (or tie the two ends together), put one loop over drawing pin, and with point of pencil in other loop describe a circle (about  $2\frac{1}{2}$ " diameter).

Make loops at the ends of the other piece of string, and describe a circle (about  $1\frac{1}{2}$ " diameter).

Place drawing pin successively at quarter points (where the ruled lines cut the outer circle) and with the longer string, as used for drawing that circle, mark (as if about to describe an arc) points on the circumference of the circle.

From the twelve points marked rule short lines pointing towards centre of circles.

Print in figures, marking hours of clock.





**Exercise XXX.****DESIGNING AND COLOURING (PLATE IV.).**

**MATERIALS.**—*Large white paper square; rule; pencil; crayons, with holders and stumps.*

Rule lines parallel to sides of square and distant one inch.  
(The measurement and ruling must be accurately done to produce a satisfactory result.)

Divide the sides of the inner square (formed by the lines just drawn) into half-inches.

Rule lines joining opposite points so as to divide space into a number of small squares. (Let the children count the number, and note eight rows with eight in each row.)

Let the children colour the squares with crayons of two or three colours to make a definite pattern. (Several previously prepared patterns, as in Plate iv., might be shown to them first, and the principle of repetition pointed out. The children should then be left without any copy to produce their own patterns.)

Rule strongly the lines forming the squares.

**THE END.**

## THIRD SERIES.



## LIST OF APPARATUS AND MATERIALS.

[Those marked with \* are the same as used in an earlier series.]

Cartridge drawing paper, pieces about 11" × 7". (*Note J*, p. 130.)

- \* Large white paper squares, 6" side.
- \* Squared drawing paper ( $\frac{1}{4}$ " squares), pieces 5" square.
- \* Coloured (various) paper squares, 4" side ; gummed on back.  
(*Note D*, Part I. p. 4.)
- \* Rule 12" long, marked in eighths.  
Small set square, with angles 60° and 30°.
- \* Lead pencil.
- \* Scissors. (*Note C*, Part I. p. 4.)
- \* Series of various coloured wools in bag. (*Note E*, Part I. p. 5.)
- \* Teacher's corresponding series of wool skeins.
- \* Box of crayons, with holders and stumps. (*Note I*, Part I. p. 68.)
- \* Modelling clay. (*Note G*, Part I. p. 6.)
- \* Earthenware vessel with lid, for holding moist clay.
- \* Modelling board.
- \* Modelling tool. (*Note H*, Part I. p. 7.)
- \* Small square wood blocks, for working clay, 3" side by  $\frac{1}{2}$ " thick.  
Small sponge.
- \* Circular disc, 3" side, by preference of metal. (Compasses with pencil leg may be used instead.)  
Iron wire, pieces 1 foot long. (*Note K*, p. 130.)  
Small flat pliers. (*Note L*, p. 130.)
- \* Drawing pins.
- \* Thin string.
- \* Pins.

## NOTES ON THE APPARATUS AND MATERIALS, AND THEIR USE.

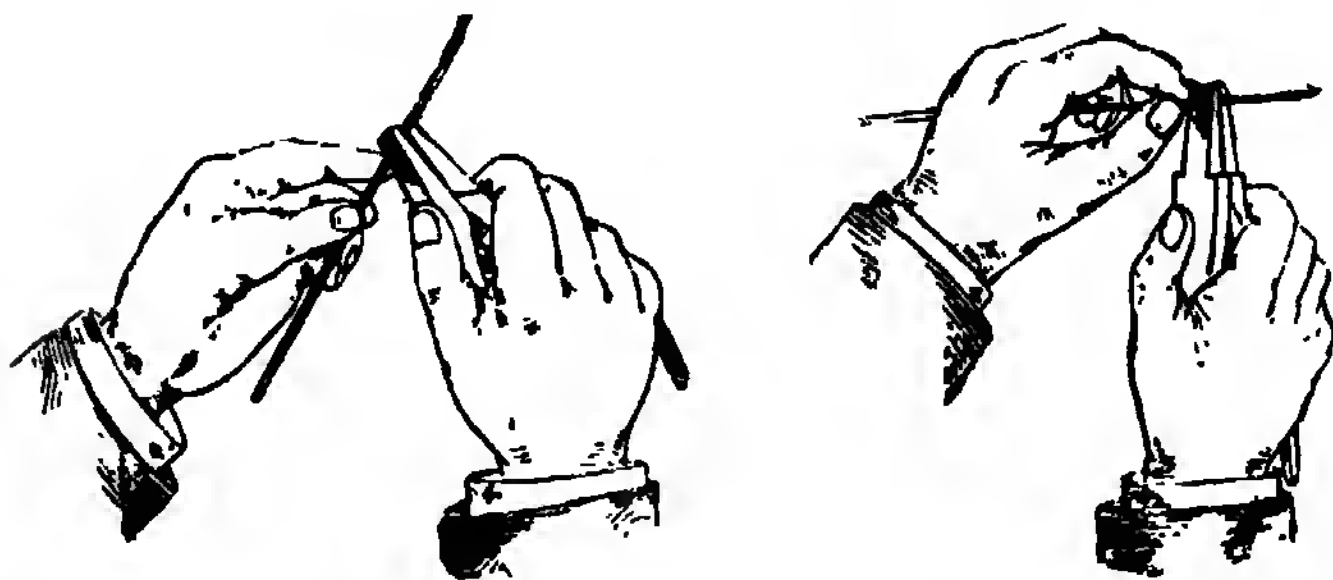
Notes on some of the materials which have been used in the First and Second Series of exercises will be found in Part I., and should be consulted!

(J) *Cartridge drawing paper*.—Ordinary drawing paper will do, but it should be stout enough for making simple paper models. For some exercises, pieces half the size given in the preceding list are required, but the larger pieces are readily folded and torn or cut in two with a paper-knife.

(K) *Iron wire*.—This should be about No. 18 in thickness, and cut into pieces 1 foot long. It may be had in bundles containing about two hundred such pieces. It need scarcely be said that it should be kept in a dry place to prevent it from getting rusty.

(L) *Small flat pliers*.—These are for use in bending and breaking the iron wire, and should not be too large for the children to hold and use comfortably.

To bend the wire, it should be held in the pliers with the point at which it is to be bent close to one edge of the pliers; the bending should then be done by the pressure of the forefinger or thumb as close to the pliers as possible, as in the accompanying figures.



The wire can also be straightened by means of the pliers, if necessary.

In order to break the wire at any point, it should be held firmly with the pliers close to the point, and then bent backwards and forwards several times.

**Exercise I.****DRAWING WITH SET SQUARE, AND CUTTING.**

**MATERIALS.**—*Cartridge paper (half-sheet) ; rule ; set square ; lead pencil ; scissors.*

Rule line 4" long near shorter edge of paper.

Draw perpendicular 4" long at each end of line, by help of set square. (To do this, hold ruler firmly against line, place proper edge of set square against ruler (Fig. 1), and slide it along to proper point ; then remove ruler, meanwhile holding set square firmly in position.)

Join ends of perpendiculars by a line, and measure its length.

Cut out square with scissors.

Let children then by themselves construct another (smaller) square on remainder of paper, and cut out.

[If there is time, rule diagonals of the larger square, cut it up into four triangles, and lay these together (as shown in Fig. 3) to form two complete squares, noting the right angles and half right angles.]

FIG. 1.

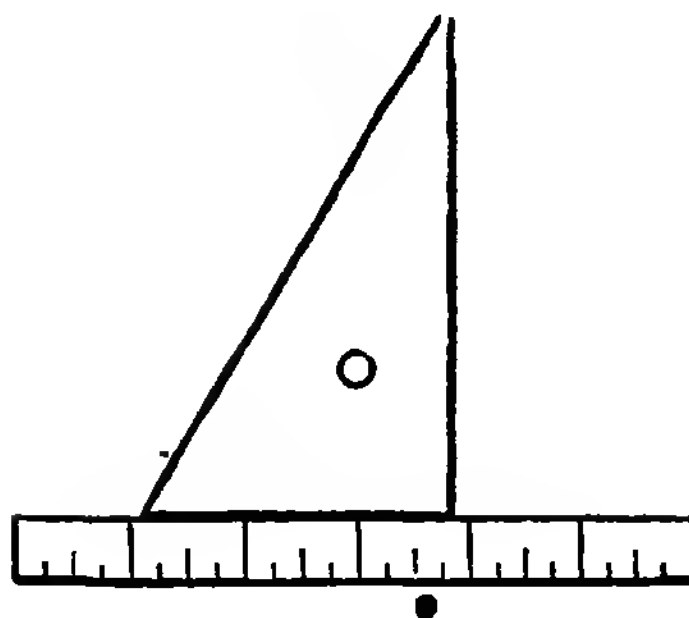


FIG. 2.

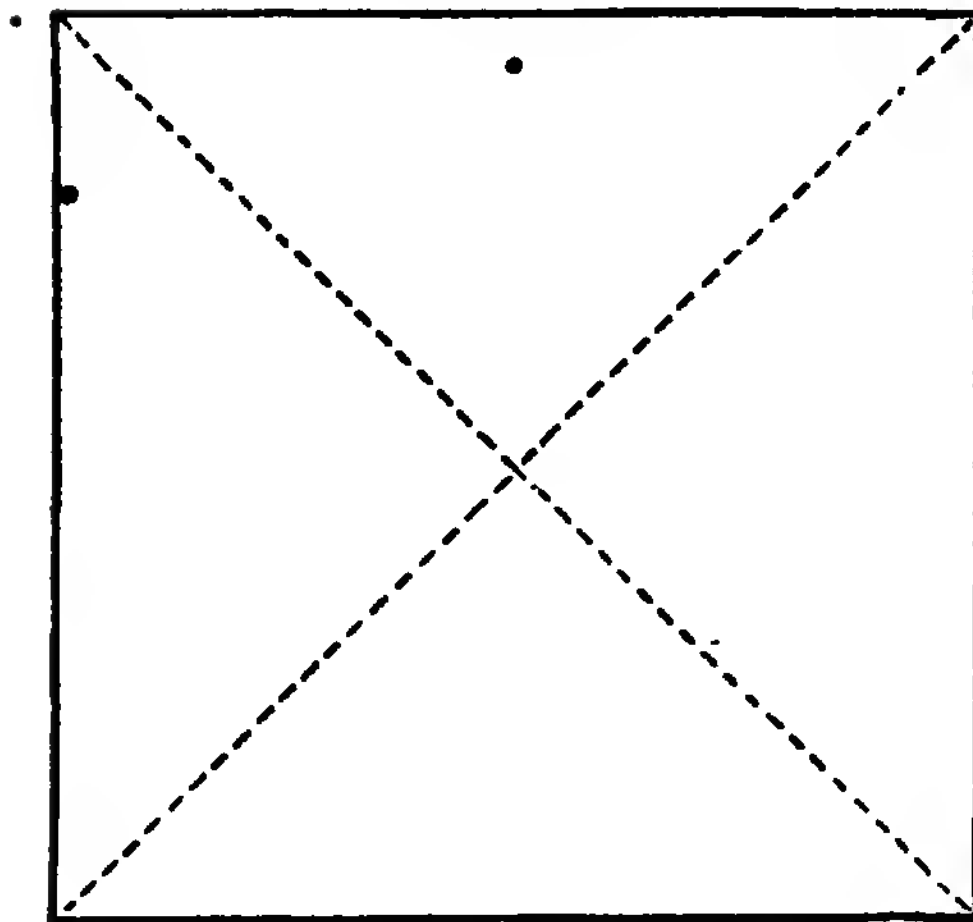
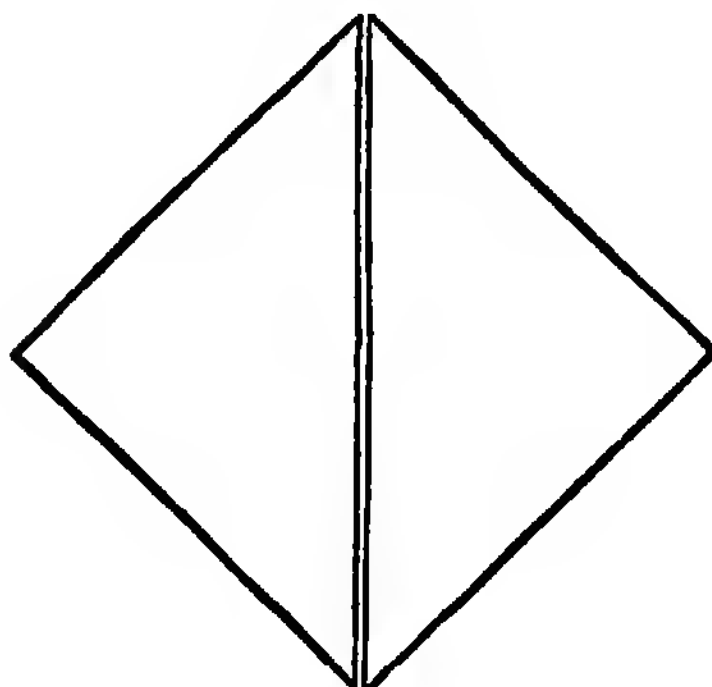


FIG. 3.





**Exercise II..****DRAWING WITH SET SQUARE, AND CUTTING.**

**MATERIALS.**—*Cartridge paper (half-sheet) ; rule ; set square ; lead pencil ; scissors.*

Draw square of 4" side, as in last exercise.

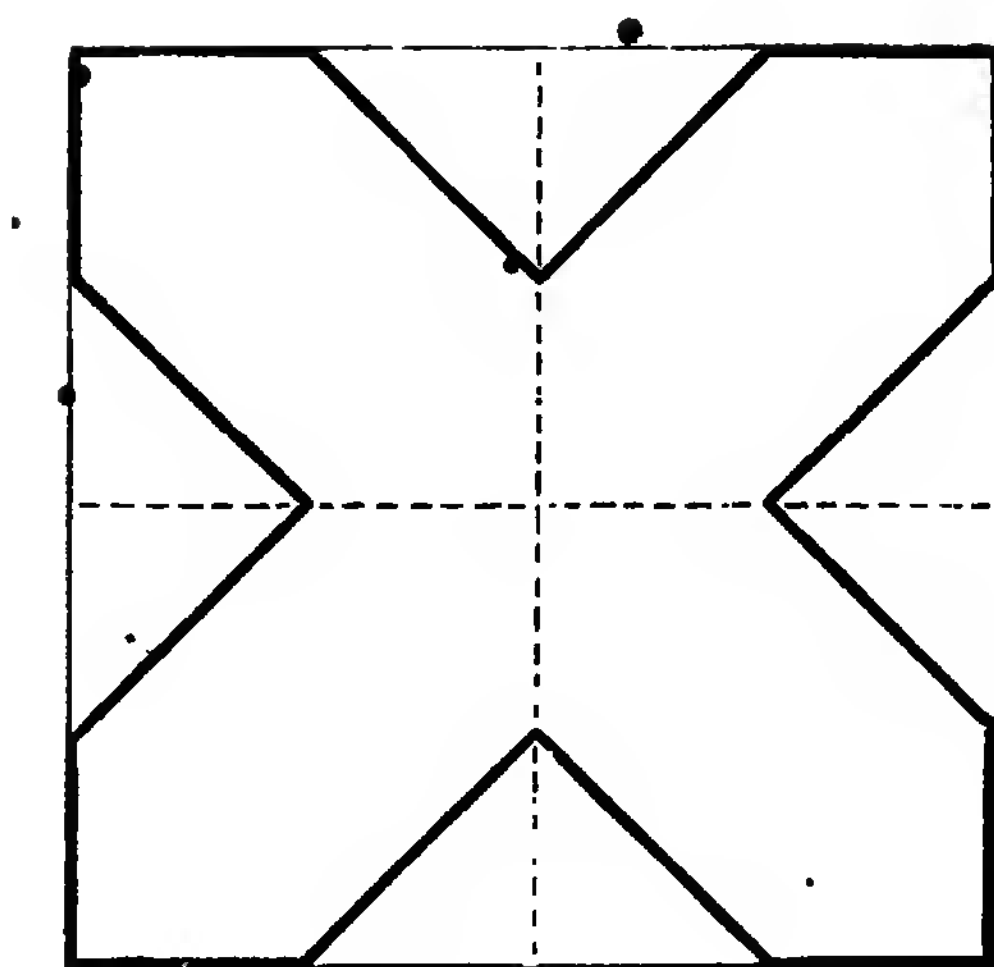
Find by measurement middle points of sides, and join opposite points.

Find by measurement middle point of each side of the four small squares.

Rule lines joining marked points, as in figure. (Draw figure on blackboard.)

Thicken lines of cross (see figure).

Cut out cross along the thickened lines.



**Exercise III.****DRAWING WITH SET SQUARE, AND CUTTING.**

**MATERIALS.**—*Cartridge paper (half-sheet) ; set square ; rule ; lead pencil ; scissors.*

Rule line 4" long near one edge of paper.

Use set square to draw line at angle of  $60^{\circ}$  from each end of first line, forming a triangle (Fig. 1).

Cut out triangle, and measure sides to prove equilateral.

Children then by themselves construct and cut out similar triangle with sides 3", and another with sides 2".

Compare the three triangles with each other, to show all angles equal (Fig. 2).

[A triangle might also be constructed, using the other angle of the set square (*i.e.*  $30^{\circ}$ ), to show that it will not be equilateral.]

FIG. 1.

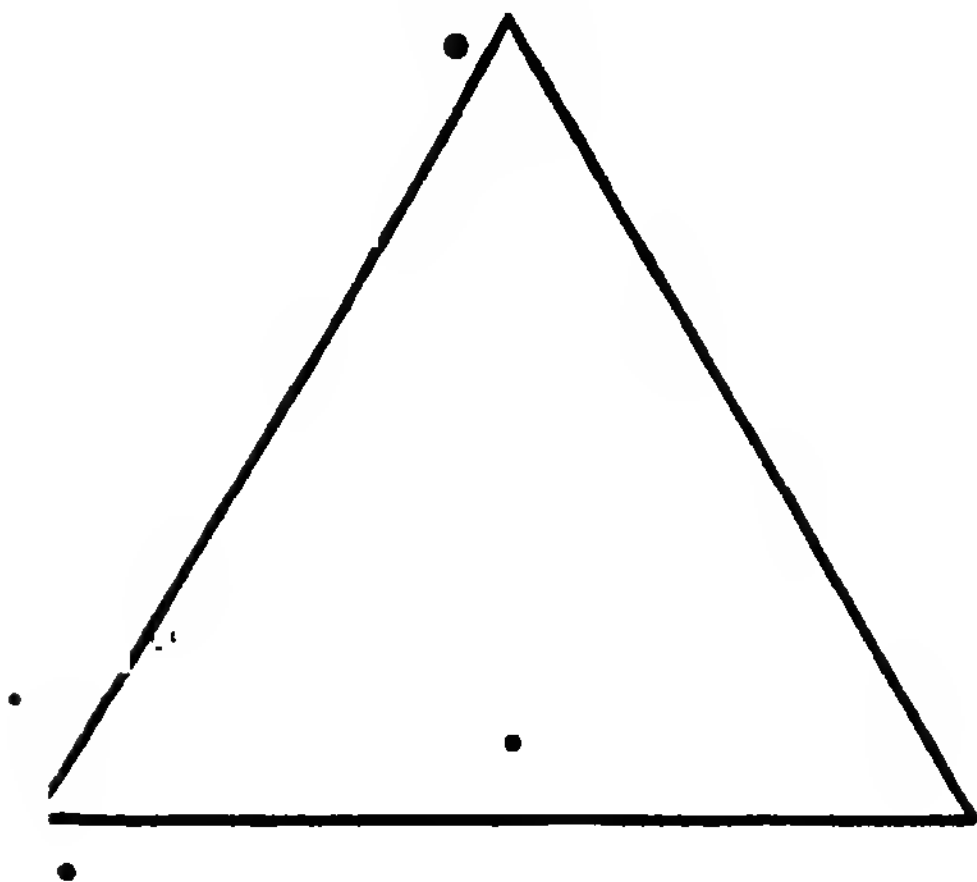
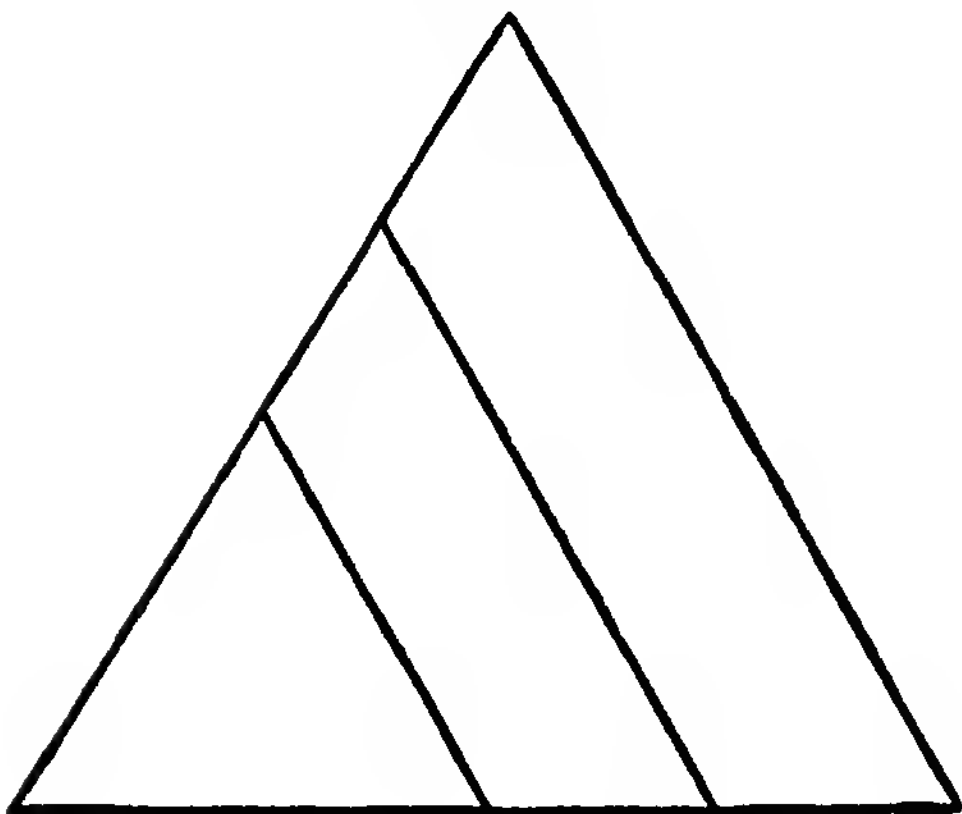


FIG. 2.



**Exercise IV.****DRAWING AND PAPER MODELLING.**

**MATERIALS.**—*Cartridge paper (half-sheet) ; rule ; lead pencil ; set square ; scissors.*

Rule line 6" long near one long edge of paper (or mark distance on edge itself, if straight).

Construct an equilateral triangle on this line by means of set square, as in last exercise.

Cut out the triangle.

Measure length of each side of triangle, and mark middle points of sides.

Rule lines joining middle points (Fig. 1).

Measure lines last drawn, to show new figure is also equilateral triangle.

Note the four similar and equal triangles.

Fold large triangle accurately along pencil lines, bend over each outer triangle on to central one, and crease carefully. (This will test accuracy of drawing and folding.)

Place three outer triangles to meet in point forming a regular tetrahedron (Fig. 2)

FIG. 1.

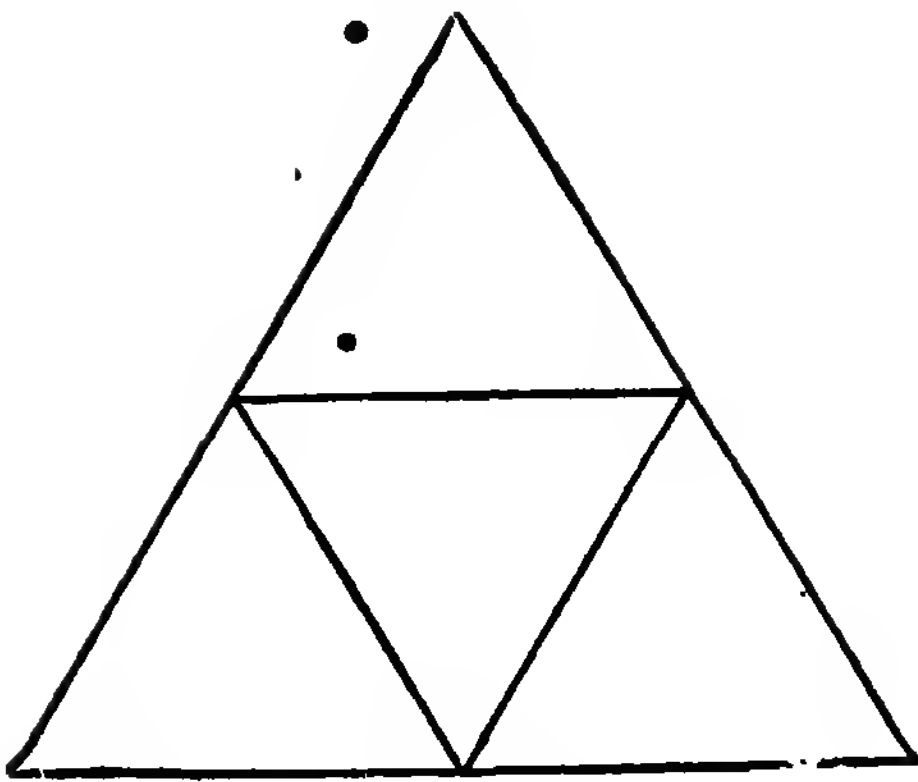
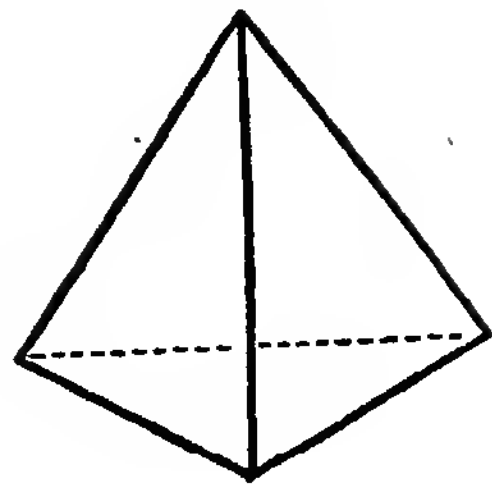


FIG. 2.



**Exercise V.****COLOUR SORTING.**

**MATERIALS.**—*Set of coloured wools in bag ; large white paper square to lay wools on. [Teacher's corresponding series of wool skeins.]*

Children select piece of same colour and shade as specimen skein shown ; repeat with several different colours.

Select particular colour asked for ; e.g. blue, bright red, light green, etc.

Select lighter or darker shades of same colour as skein shown.

Lay several shades of one colour in graduated series.

Select shades intermediate between two shown.

Select, and twist loosely together, two colours forming pleasing combination ; then two colours which do not go well together.

[Repeat the exercise several times at intervals if found necessary.]





**Exercise VI.****DRAWING AND COLOURING.**

**MATERIALS.**—*Large white paper square ; rule ; set square ; lead pencil ; crayons.*

Measure size of paper square with rule.

Draw line 4" long, about 1" distant from one edge of paper, and leaving same space at each end.

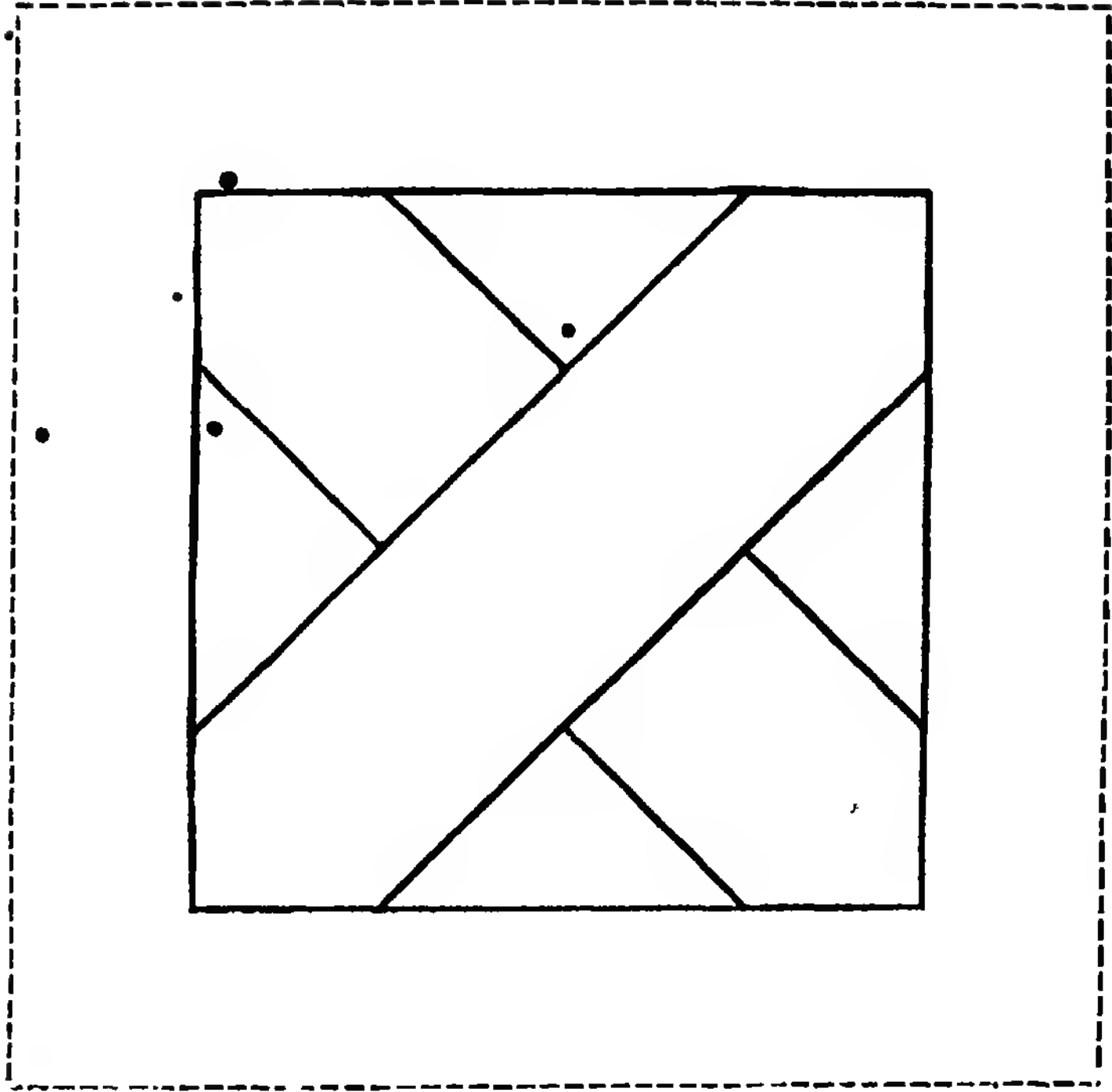
On line drawn construct a square, as in Exercise I.

Mark points on each side of drawn square distant 1" from corner.

Join marked points (as in figure) by faint lines to form a cross, letting one arm appear to lie over other.

Colour two arms of cross with different coloured crayons.

Thicken lines bordering coloured portions.



**Exercise VII.****CLAY MODELLING.**

**MATERIALS.**—*Moist clay ; modelling board ; small square wooden block ; damp sponge ; thin string (or wire) for cutting clay.*

Make piece of clay into cube, by striking it with small wooden block, and against surface of modelling board.

Convert clay cube into a sphere by first flattening the corners against the board, and then rolling it between the block and board or in the hands.

Cut clay sphere into six approximately equal parts, and roll each piece to form a ball. (Compare the sizes of the six balls.)

**NOTE.**—If the clay gets dry while working, the hands may be occasionally moistened with the damp sponge, but not so as to make the clay sticky. The quantity of clay given to each child should not be too small. (See *Note G*, Part I. p. 6.)

### **Exercise VIII.**

#### **CLAY MODELLING.**

**MATERIALS.**—*Moist clay (large-sized piece); modelling board; modelling tool; damp sponge. [Orange and lemon, or models of same.]*

Divide clay into two nearly equal portions, and roll each into sphere. •

Model one piece into form of orange, after examination of form of fruit. (Note departure from true sphere, etc.)

Model second piece into form of lemon, after examination of fruit; noting how it differs from true sphere and from orange.

Imitate roughness of fruits by slightly indenting clay with point of modelling tool.

### **Exercise IX.**

#### **CLAY MODELLING.**

• *Materials and steps same as in last Exercise, using apple and pear (or models) instead of orange and lemon.*

**Exercise X.****CUTTING PAPER AND MOUNTING.**

**MATERIALS.**—*Coloured gummed paper square ; large white paper square ; lead pencil ; ruler ; scissors ; damp sponge.*

Fold coloured square twice at right angles (coloured side inwards), to make four smaller squares.

Crease, open out, and cut carefully along crease-lines.

Fold each small square into four, crease, and cut.

Select nine well-cut squares for mounting.

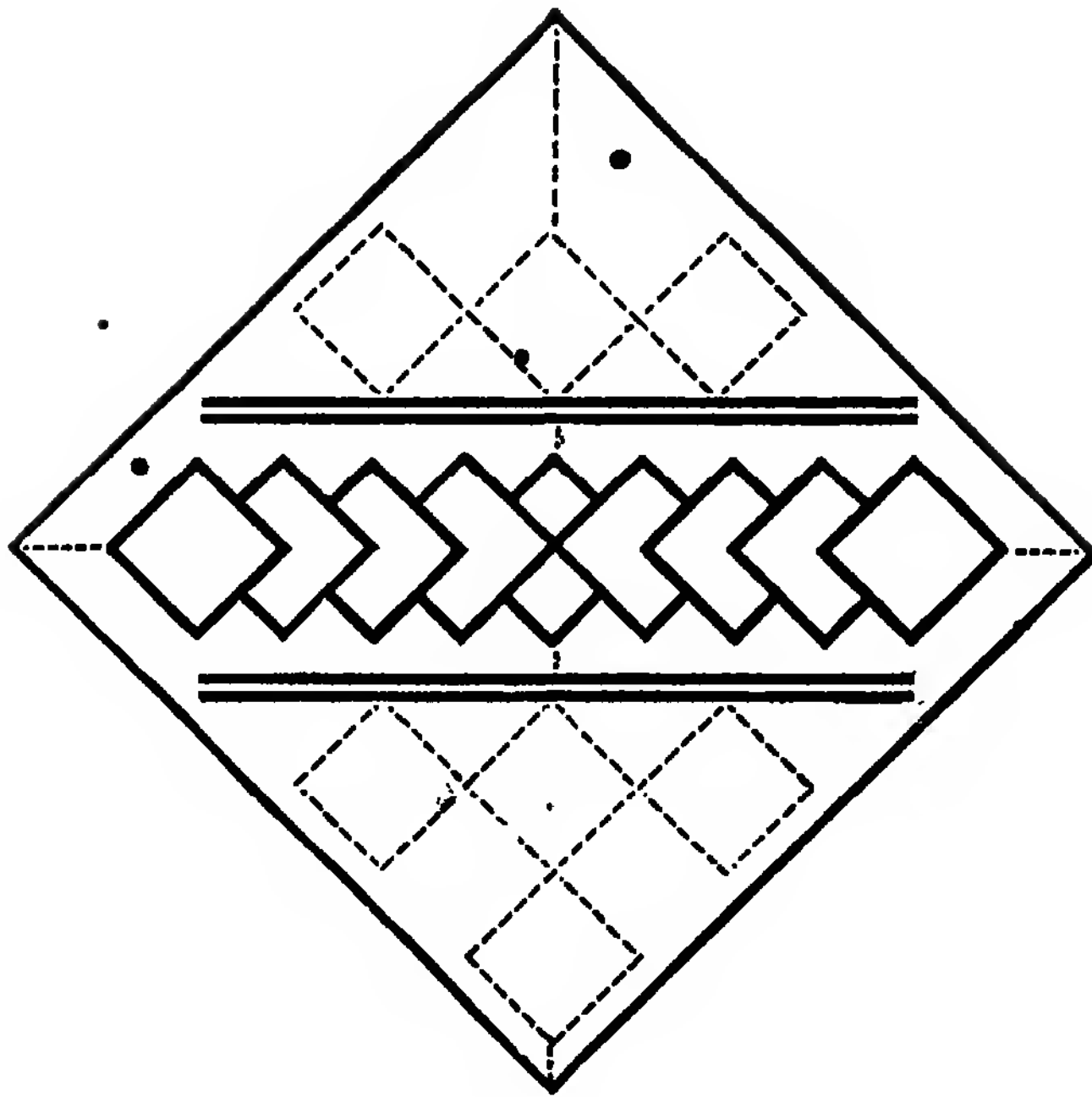
Rule diagonals faintly on white paper square.

Mount one small coloured square symmetrically in centre of white square, with its angles on the diagonals. (A piece of paper might be supplied to the children to lay over the coloured squares while pressing them down in mounting.)

Mount four small squares on each side of first, along one diagonal, each square overlapping to middle of preceding one.

Rule parallel lines nearly touching corners of small squares.

[Let children lay the remaining squares symmetrically according to their own design, *e.g.* as shown by dotted lines in figure, and mount approved designs.]



**Exercise XI.****DESIGNING AND MOUNTING (PLATE I.).**

**MATERIALS.**—*Coloured gummed paper square (each pair of children having colours that go well together) ; large white paper square ; scissors ; damp sponge.*

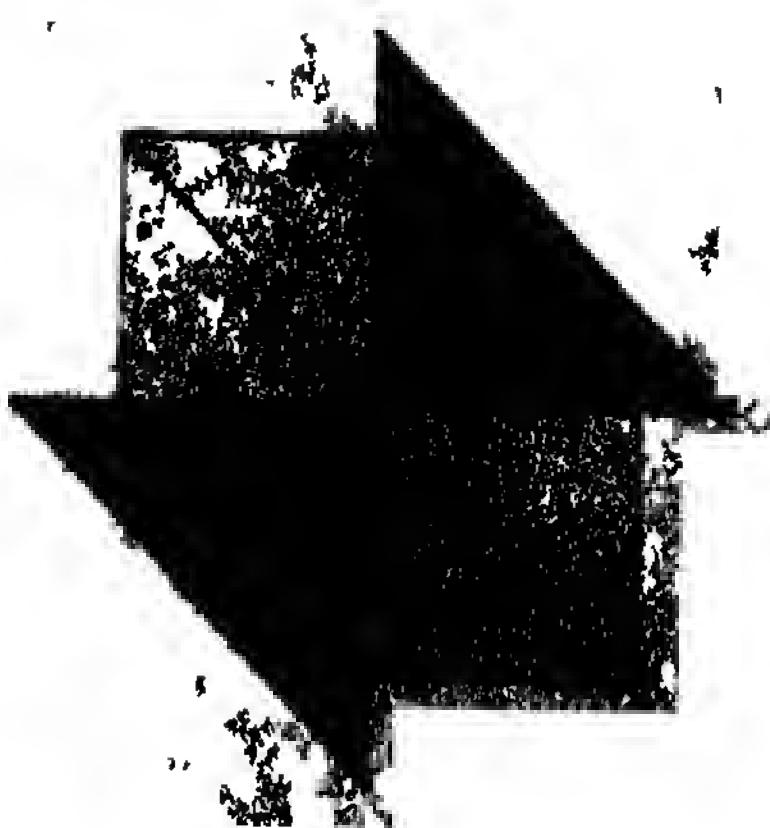
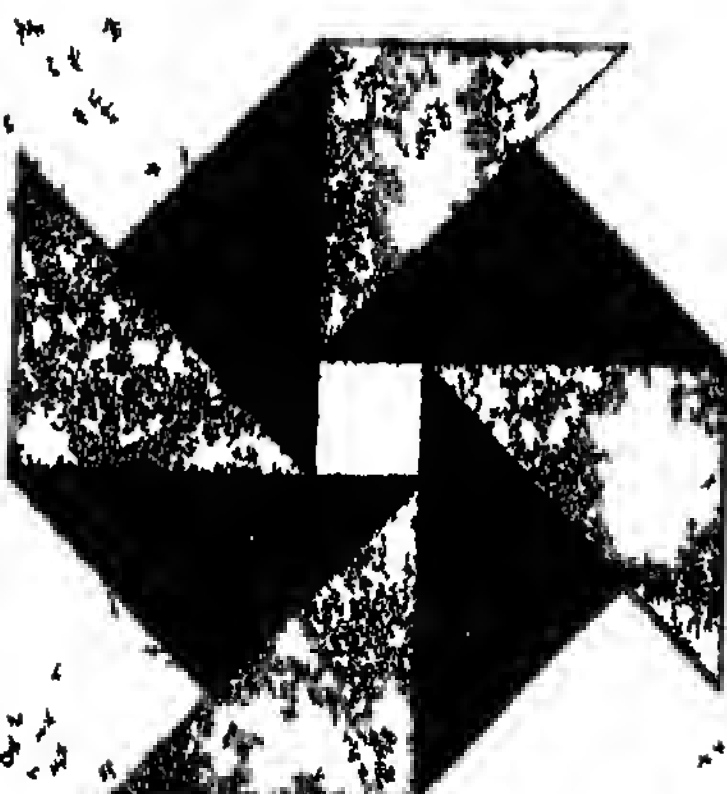
Fold coloured square twice at right angles ; crease, open out, and cut carefully into four smaller squares.

Change two small squares with neighbour for two of another colour.

Fold each of four squares carefully along one diagonal ; crease, open out, and cut carefully into two triangles.

Children lay the eight triangles on white square to form their own design.

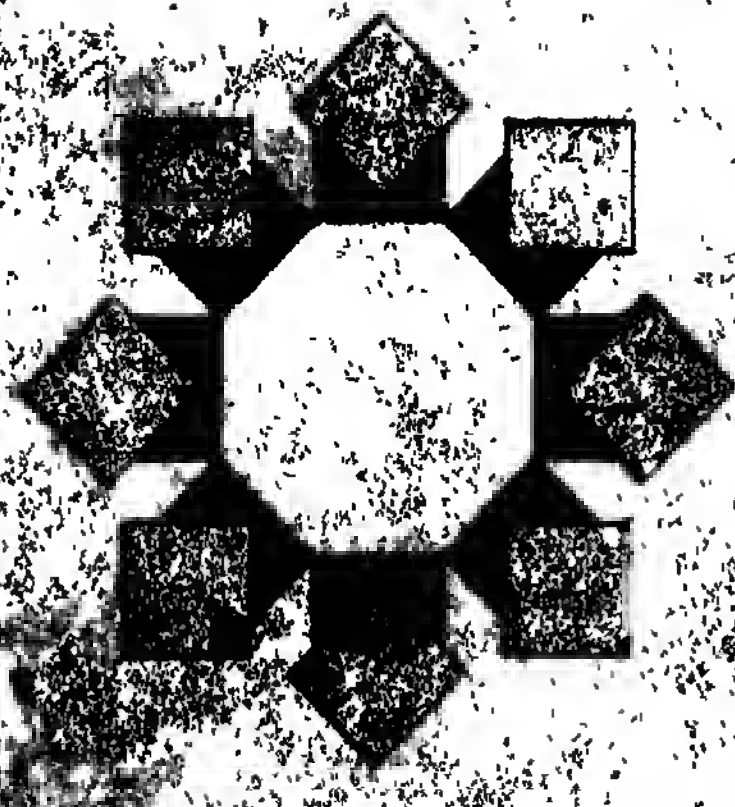
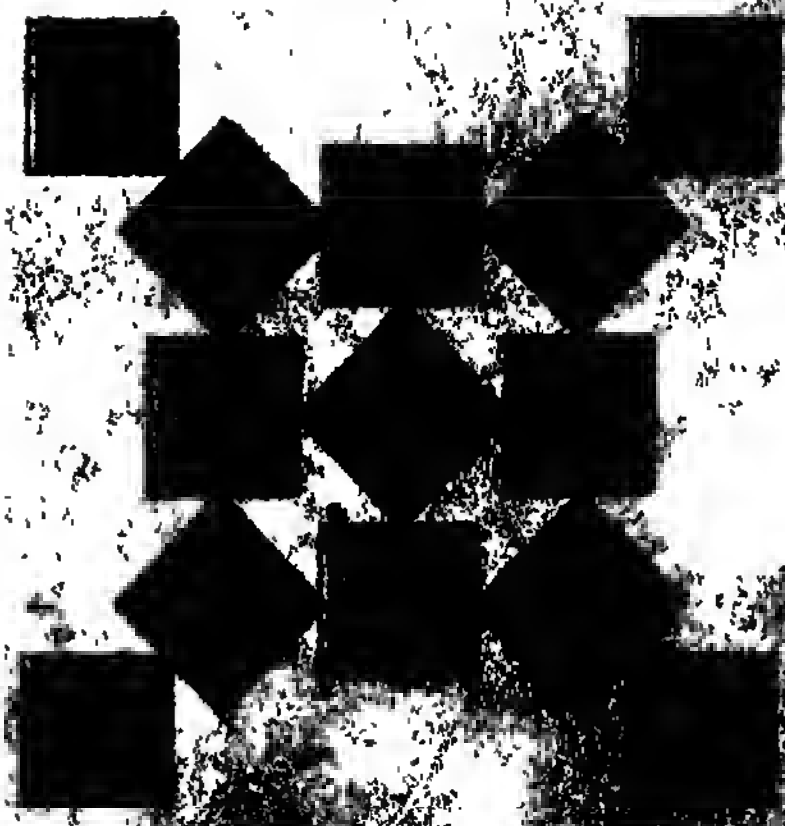
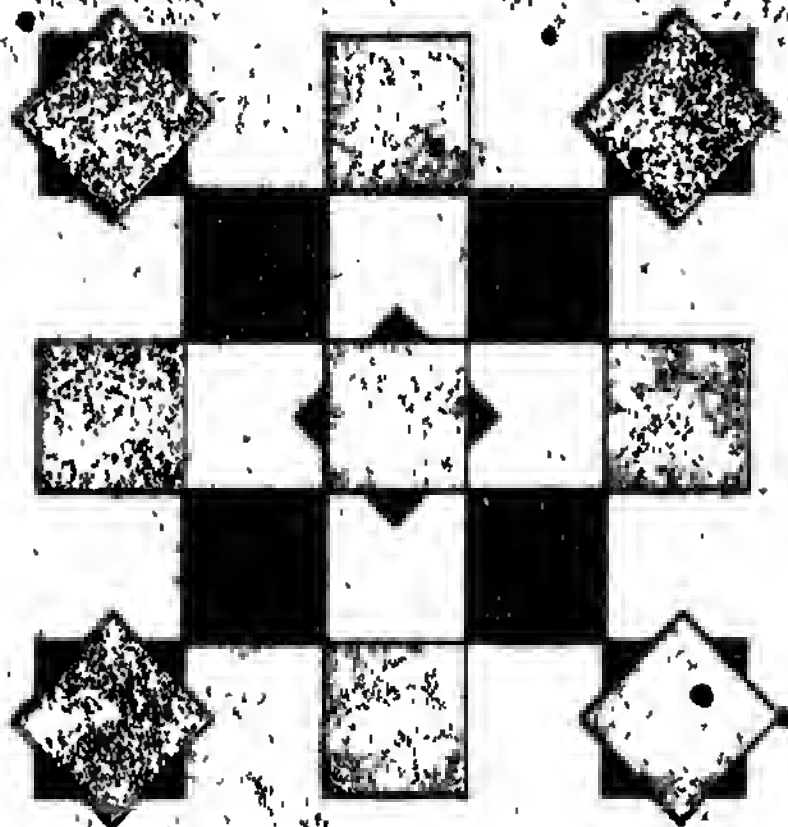
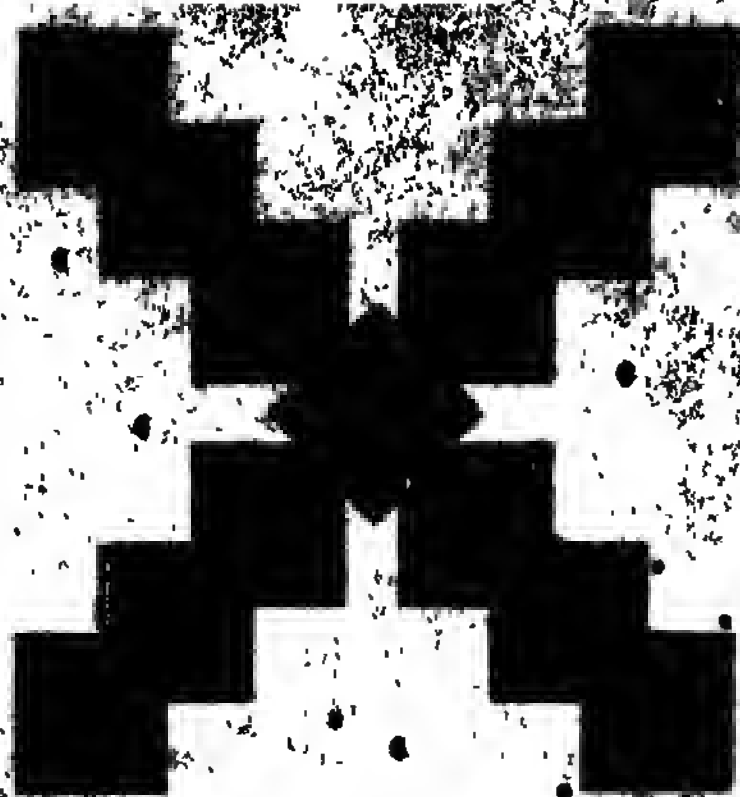
[The children should first be left to form designs for themselves ; but if there is any difficulty in getting them to do this, show them several designs previously prepared (see Plate I.) from similar pieces ; let them note the symmetrical arrangement of the parts, and then lay away the patterns and leave the children again to themselves.]











## **Exercise XII.**

### **DESIGNING AND MOUNTING (PLATE II.).**

**MATERIALS.**—*Coloured gummed paper square (each pair of children having colours that go well together); large white paper square; scissors; damp sponge.*

Fold coloured square into four smaller squares; crease, open out, and cut.

Change two squares with neighbour for two of another colour. Fold each square again into four smaller squares, and cut, to get sixteen squares in all.

Children lay pattern of their own design on white paper square, with from ten to sixteen pieces of two colours.

Mount approved designs on white paper square (faintly ruling diagonals or middle lines, if necessary, to help in the mounting).

[The children should be again left as much as possible to themselves, and not shown previously prepared patterns until they have first tried without such aid. And even when the patterns have been shown, they should be again laid aside, and the children encouraged to reproduce them from memory. Examples of patterns formed from such pieces are shown on Plate II.]

**Exercise XIII.****WIRE MODELLING.**

**MATERIALS.**—*Stout iron wire, about 12" long; rule; flat pliers; lead pencil; white paper square.* (See Notes K, L, p. 130.)

Rule lines on paper, making right angle, obtuse angle, and acute angle respectively.

Measure piece of wire 2" long, hold close to that point with pliers, and break wire by bending it backwards and forwards several times.

Break remainder of wire into pieces 2" long in same manner.

Hold one small piece of wire at middle point by pliers, and bend there to form right angle. Lay bent wire over drawing on paper, to test accuracy.

Bend second piece of wire to form obtuse angle, and third piece to form acute angle, equal in each case to angles previously drawn. Lay bent wires over drawing, to test.

Bend remaining pieces of wire at point about one-third distance from one end, to form angles same as before; and lay on paper parallel to others (see figures).

FIG. 1.

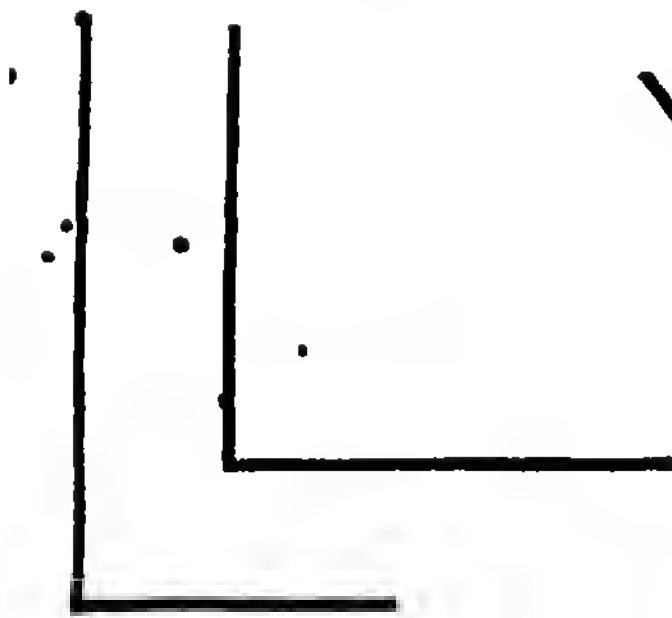


FIG. 2.

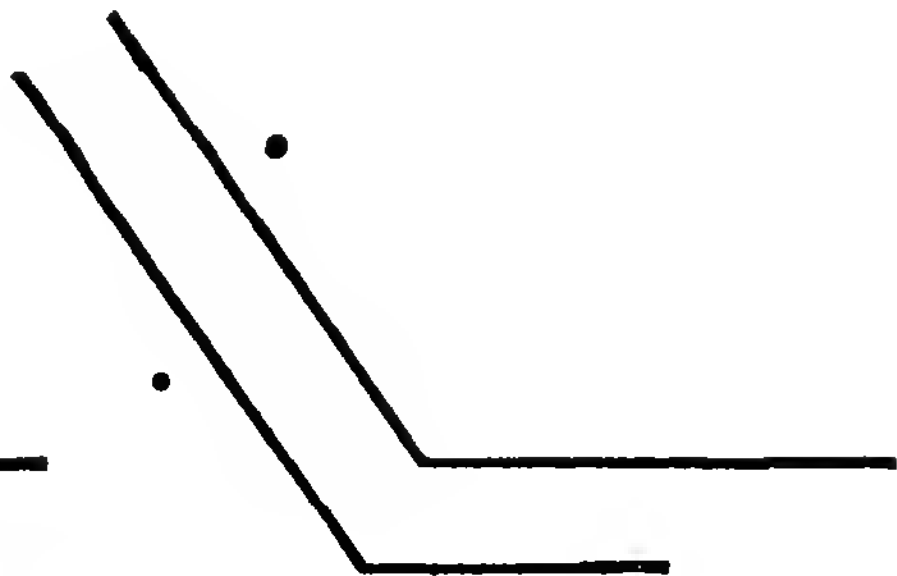
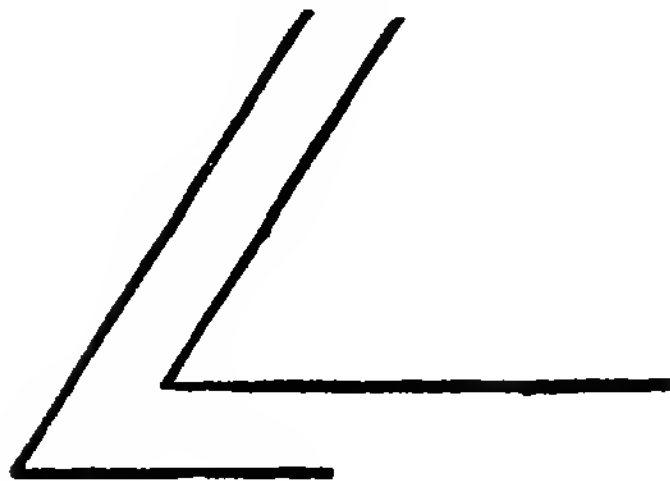


FIG 3.



**Exercise XIV.****WIRE MODELLING.**

**MATERIALS.**—*Iron wire ; rule ; pliers ; white paper square ; set square ; lead pencil.*

Measure piece of wire 8" long, break off, and use for following steps.

Find point 2" from end of wire ; bend sharply there to form right angle.

Bend wire at right angles at other points 2" apart, to complete square. (Make square so as to lie flat on desk or table.)

[If there is time, a square of 2" side should be drawn, by aid of set square, on piece of paper, and wire square laid on it for comparison.]

Measure remaining piece of wire.

Find points at which to bend wire to form a triangle having base 1" long and two sides equal to each other.

FIG. 1.

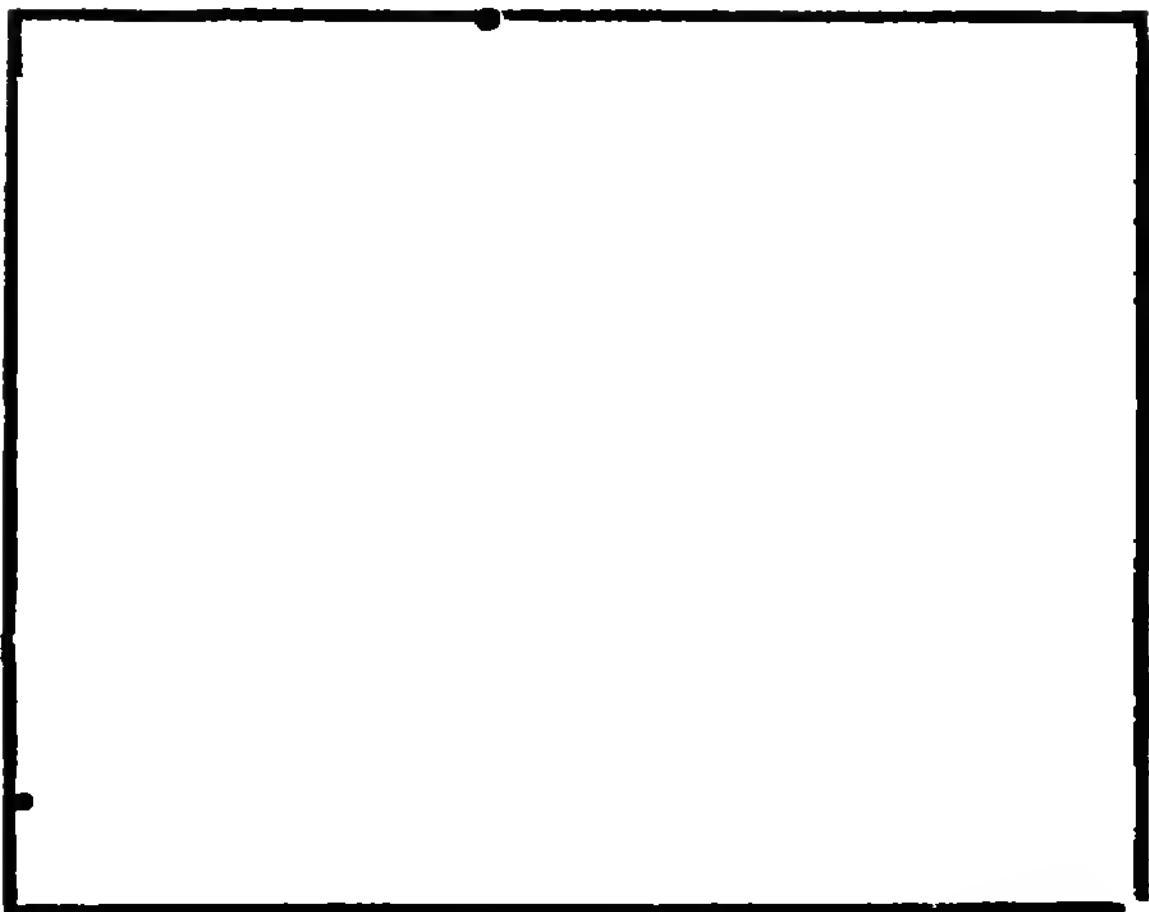
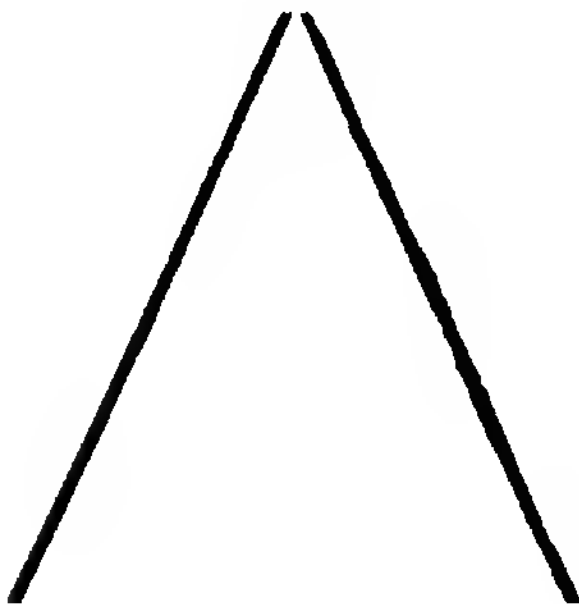


FIG. 2.





**Exercise XV.****WIRE MODELLING.**

**MATERIALS.**—*Iron wire ; pliers ; white paper square ; set square ; lead pencil ; rule.*

Draw on white paper an oblong (rectangle) having long sides 3", and short sides  $1\frac{1}{2}$ ".

Break off length of wire required to construct similar and equal figure.

Bend wire at right angles, at measured distances, to form oblong.

Lay wire model over drawing for comparison.

Measure remaining piece of wire, and bend to form equilateral triangle.

FIG. 1.

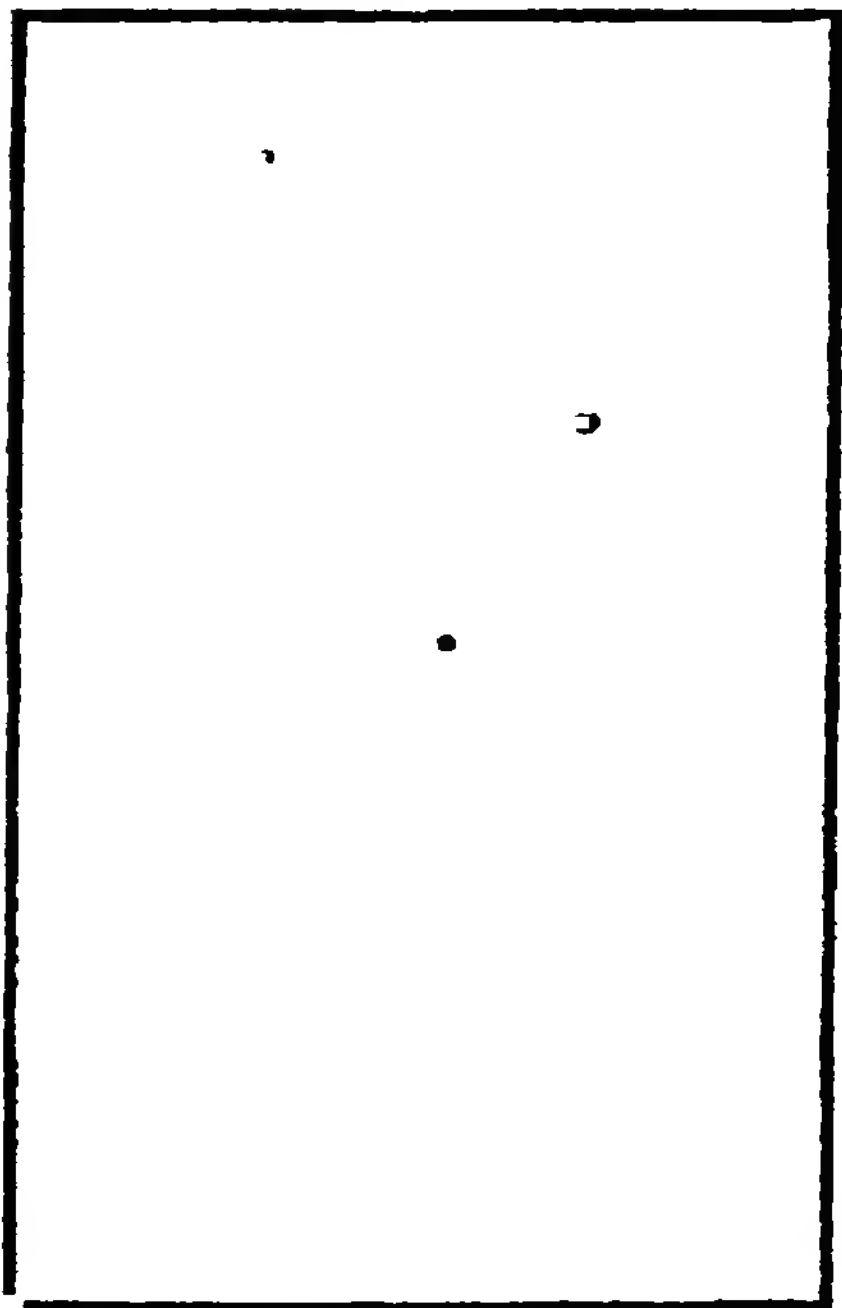
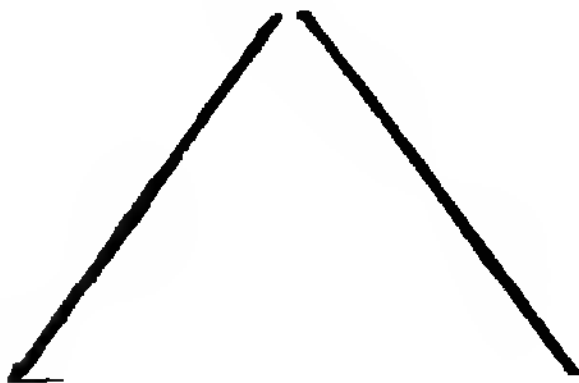


FIG. 2.



**Exercise XVI.****DRAWING, CUTTING, AND MOUNTING.**

**MATERIALS.**—*Squared paper ; lead pencil ; ruler ; coloured gummed paper square ; large white paper square ; scissors ; pin ; damp sponge.*

Rule on squared paper a square with side fourteen units (squares) long.

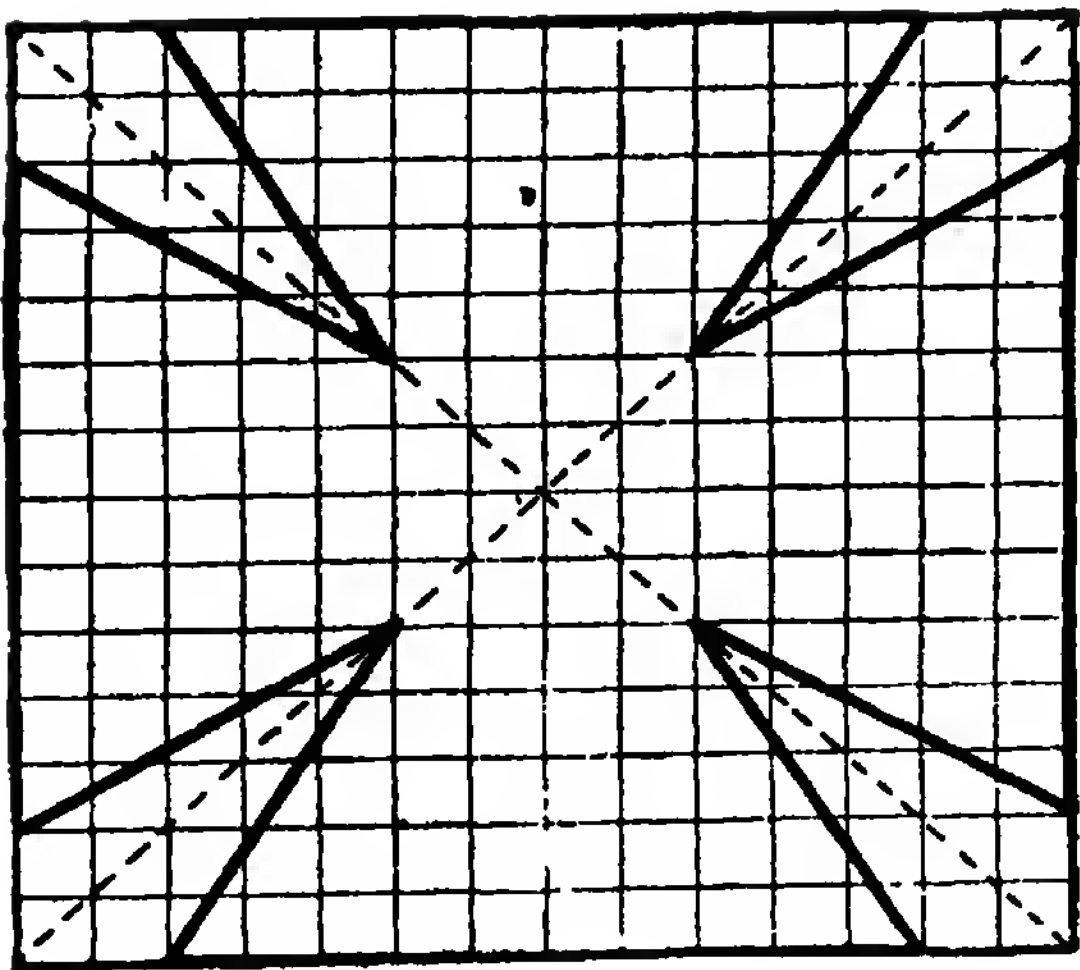
Rule faintly diagonals of square, and on diagonals mark points distant two squares from their point of intersection.

Mark points on sides of square distant two squares from the corners, and rule lines from these points to those previously marked on diagonals, to form Maltese cross (see figure).

Lay drawing on coloured paper square, and prick through with pin all corner-points of the figure. (Hold the drawing firmly in position with one hand while this is being done.)

Rule lines on front or back of coloured paper square, joining pricked points, to reproduce the figure.

Cut out figure carefully with scissors, and mount on white paper square. (First lay cut-out figure in proper position on white square, and mark two or three corner-points with pencil, so as to guide in mounting it after being damped.)



**Exercise XVII.****DRAWING, CUTTING, AND MOUNTING.**

**MATERIALS.**—*Squared paper ; lead pencil ; ruler ; coloured gummed paper square ; large white paper square ; scissors ; pin ; damp sponge.*

Rule on squared paper a square with side of sixteen units, and rule diagonals of square.

Mark points on diagonals at distance of four squares from their intersection, and rule lines from those points to the corners of the square (see figure).

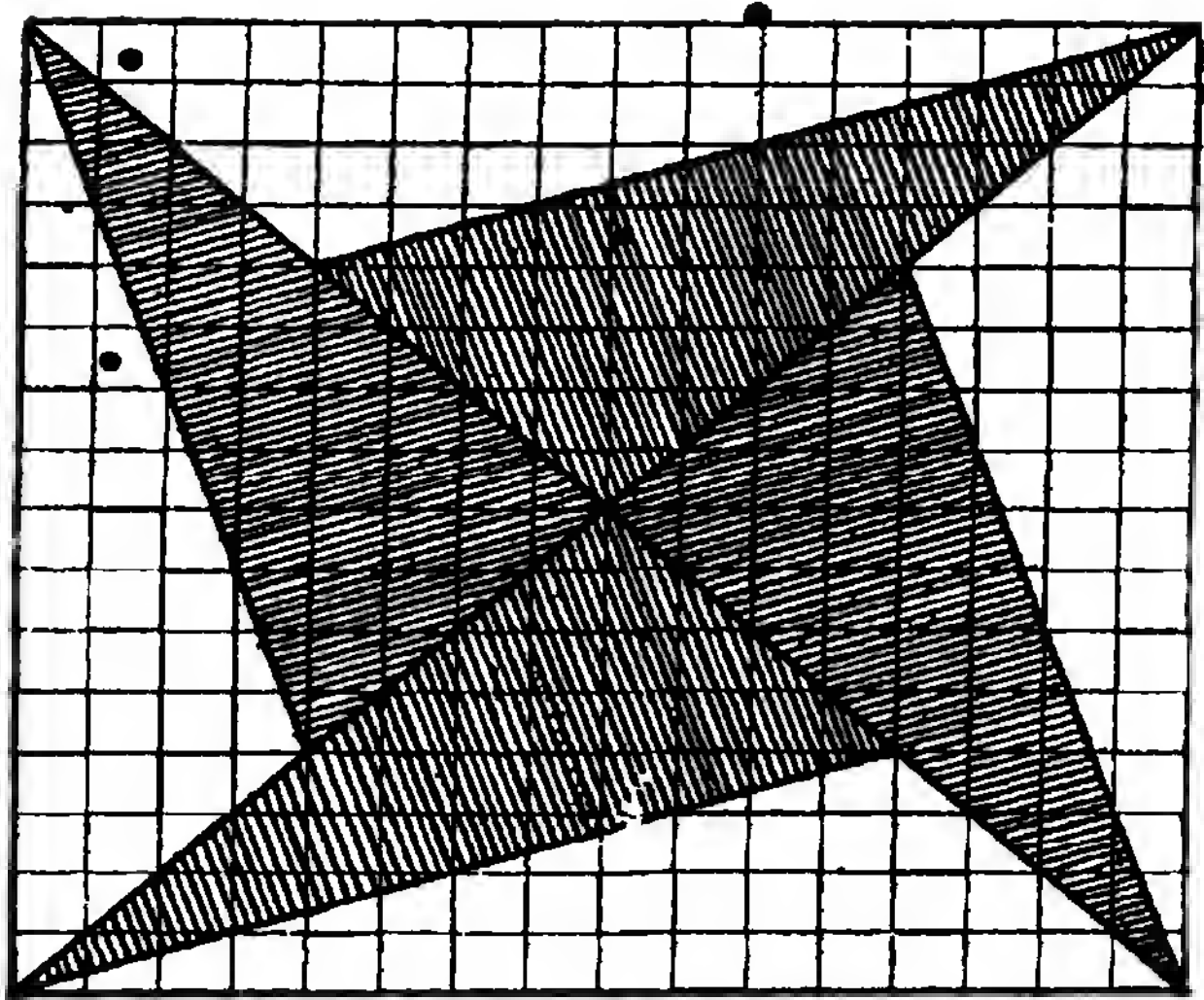
Lay drawing on coloured gummed square, and prick through the corners of *one* of the triangles meeting in the middle of the square.

Rule lines on coloured square joining pricked points, and cut out the triangle.

Cut out three other similar triangles (using the one first cut out as a pattern, or pricking through the points as before).

Mount the four coloured triangles symmetrically on white paper square, to reproduce drawn figure.

**NOTE.**—It is intended that the four triangles should be separately drawn and cut out, as a test of accurate work, rather than that the figure should be drawn and cut out as a whole.



**Exercise XVIII.****DRAWING AND COLOURING.**

**MATERIALS.**—*Squared paper ; ruler ; lead pencil ; large white paper square ; pin ; crayons.*

Rule two lines across paper, parallel to each other, and twelve squares apart.

Mark off points at distance of twelve squares from same end of each of above lines, and join points to form a square with side of twelve units.

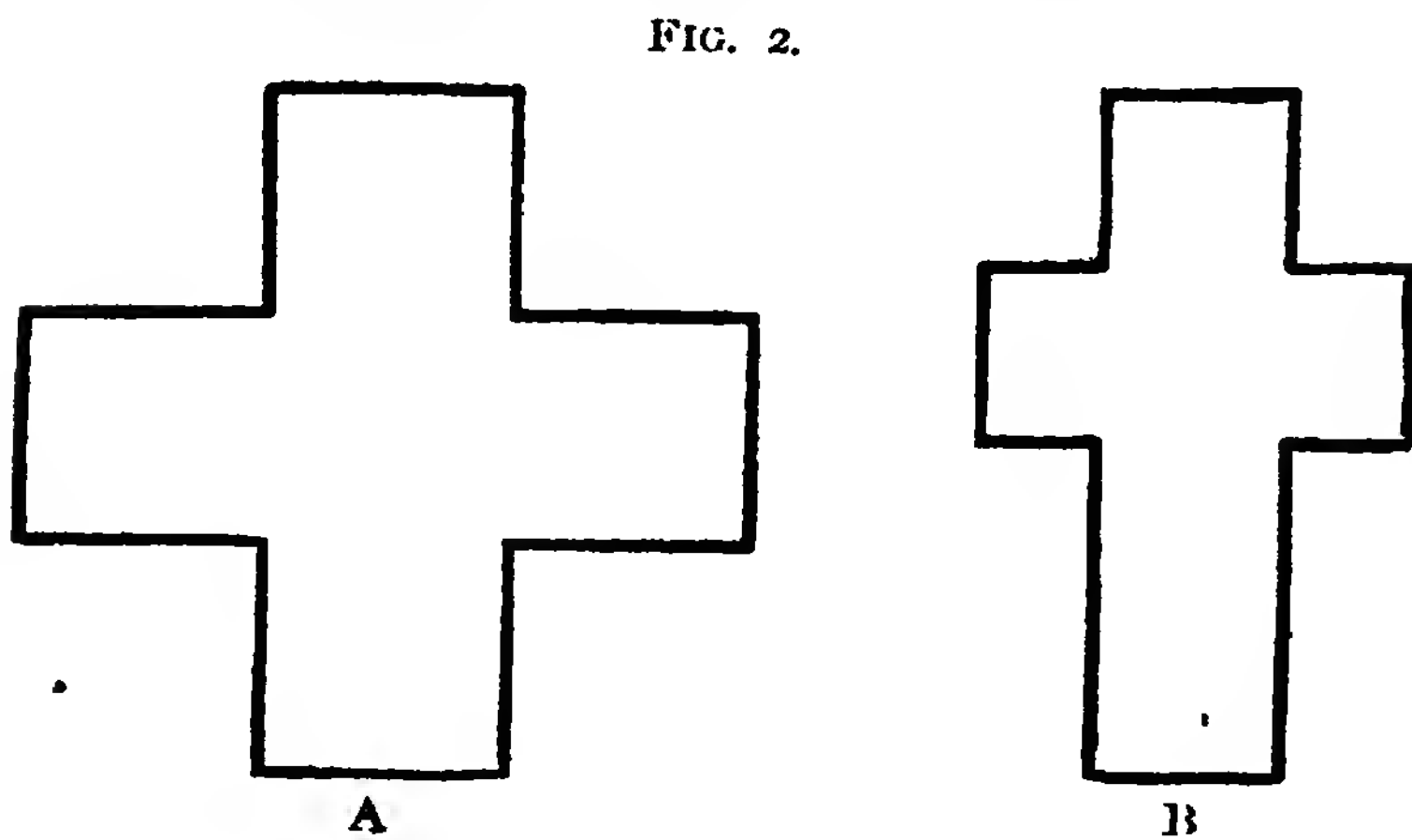
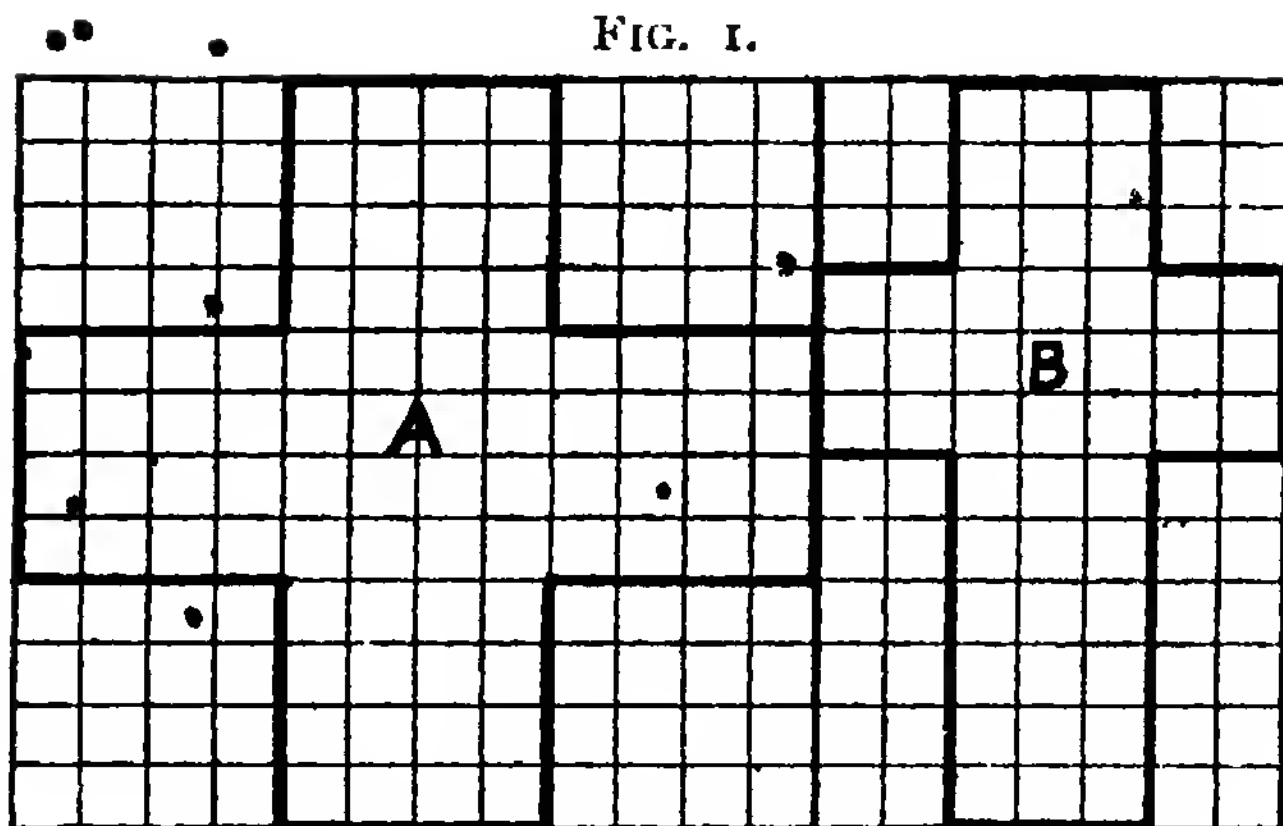
Divide each side of this small square into three equal parts, and rule lines to form Greek cross (Fig. 1, A).

Draw Latin cross (Fig. 1, B) with upright and arms having breadth of three squares, and with arms projecting distance equal to two squares.

Lay drawing on white paper square, and prick through corners of Greek cross ; rule lines joining points, so as to reproduce figure.

Do the same with the Latin cross, but arrange so that the two crosses on the white paper are separated by a space (Fig. 2).

Colour the figures with crayons.





**Exercise XIX.****DRAWING AND COLOURING.**

**MATERIALS.**—*Large white paper square ; rule ; lead pencil ; set square ; crayons.*

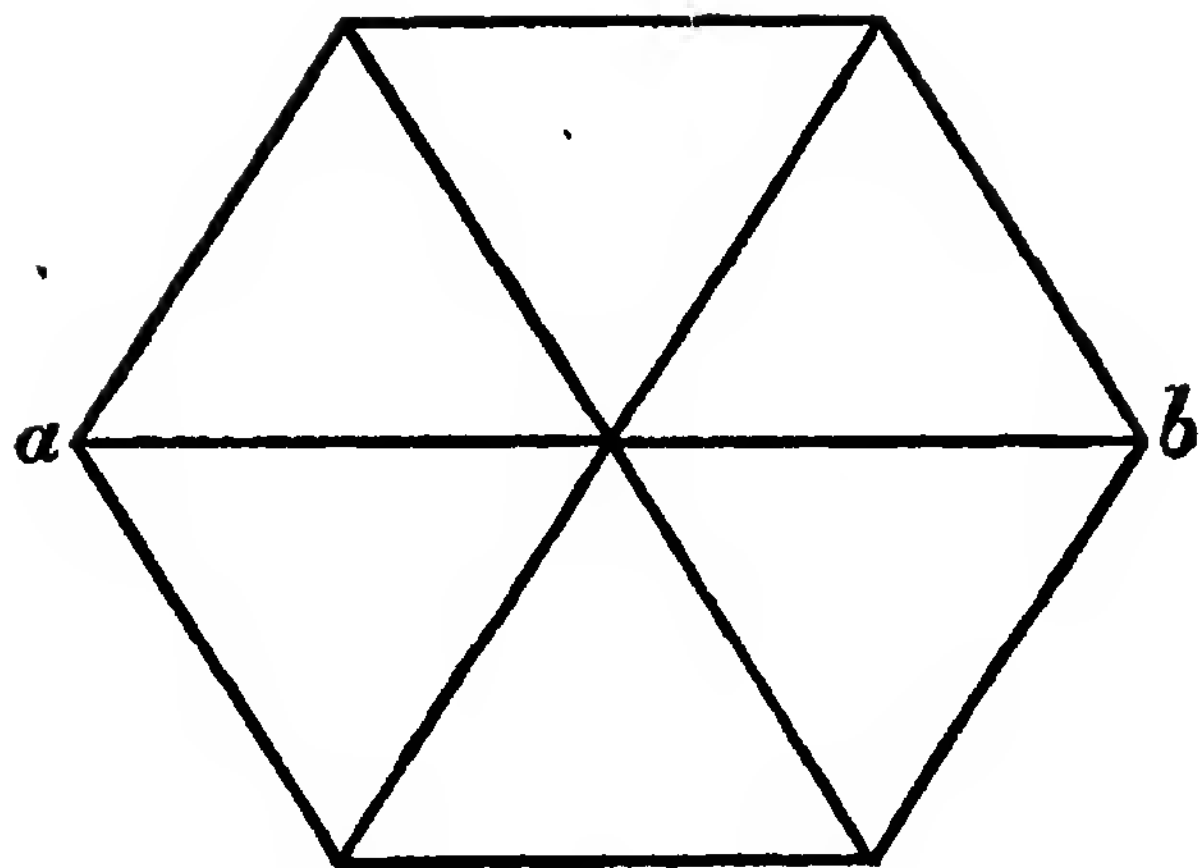
Rule line (*a b* in figure) 4" long about middle of white paper square, and mark middle point of line.

Through middle point of line thus drawn rule lines of equal length (2" on each side middle point), making angles of  $60^{\circ}$  with it, by means of ruler and set square.

Join ends of lines to form hexagon. Note six equilateral and equal triangles.

Colour triangles of hexagon in two or three colours, and then rule strongly the lines of the triangles.

[The equality of the triangles might be tested by pricking through points of *one* small triangle to second piece of paper, carefully ruling lines joining the points, and cutting out the triangle so drawn with scissors. This triangle might then be applied in succession to the six triangles forming the hexagon.]



**Exercise XX.****CLAY MODELLING.**

**MATERIALS.**—*Moist clay; modelling board; small square wooden block; thin string to cut clay; rule; lead pencil; piece of paper. [Eight small wooden cubes for teacher's illustration.]*

Make clay into cube, as in Exercise VII., making edges and corners as sharp as possible.

Measure various edges of cube with rule, and write down lengths on paper.

Cut cube with thin string into eight smaller cubes, as shown by dotted lines in Fig. 1. (This might be illustrated by the teacher building up a cube out of eight small wooden cubes.)

Measure edges of small cubes, and write down measurements on paper.

Lay cubes of clay in two rows of four each, to form oblong block (Fig. 2); measure dimensions of block as to length, breadth, and thickness, and write down measurements on paper.

● FIG. 1.

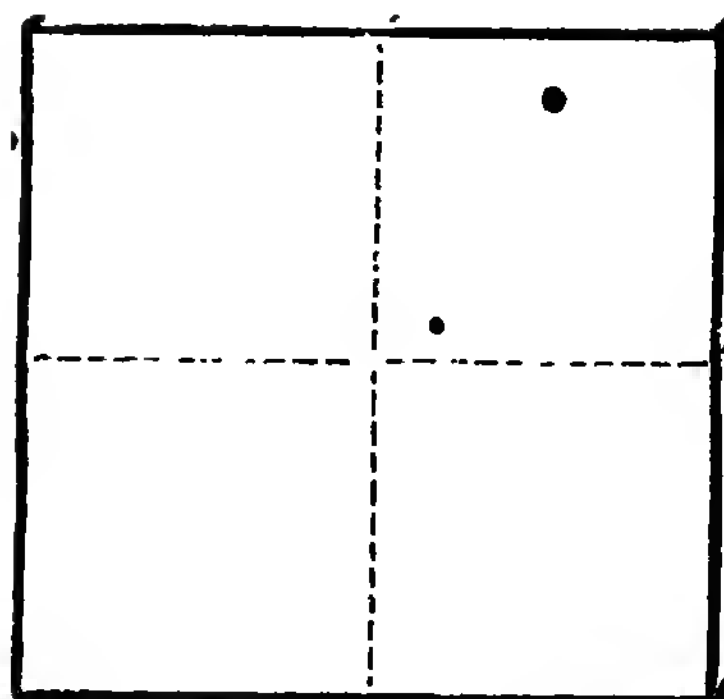
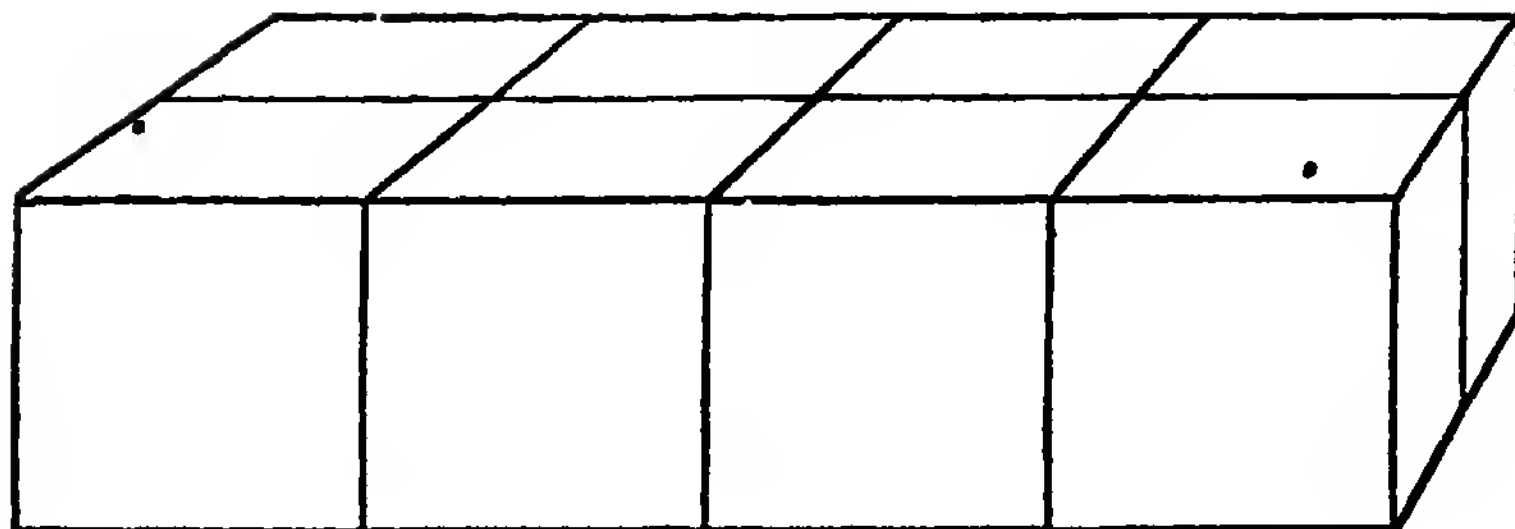


FIG. 2.



**Exercise XXI.****CLAY MODELLING.**

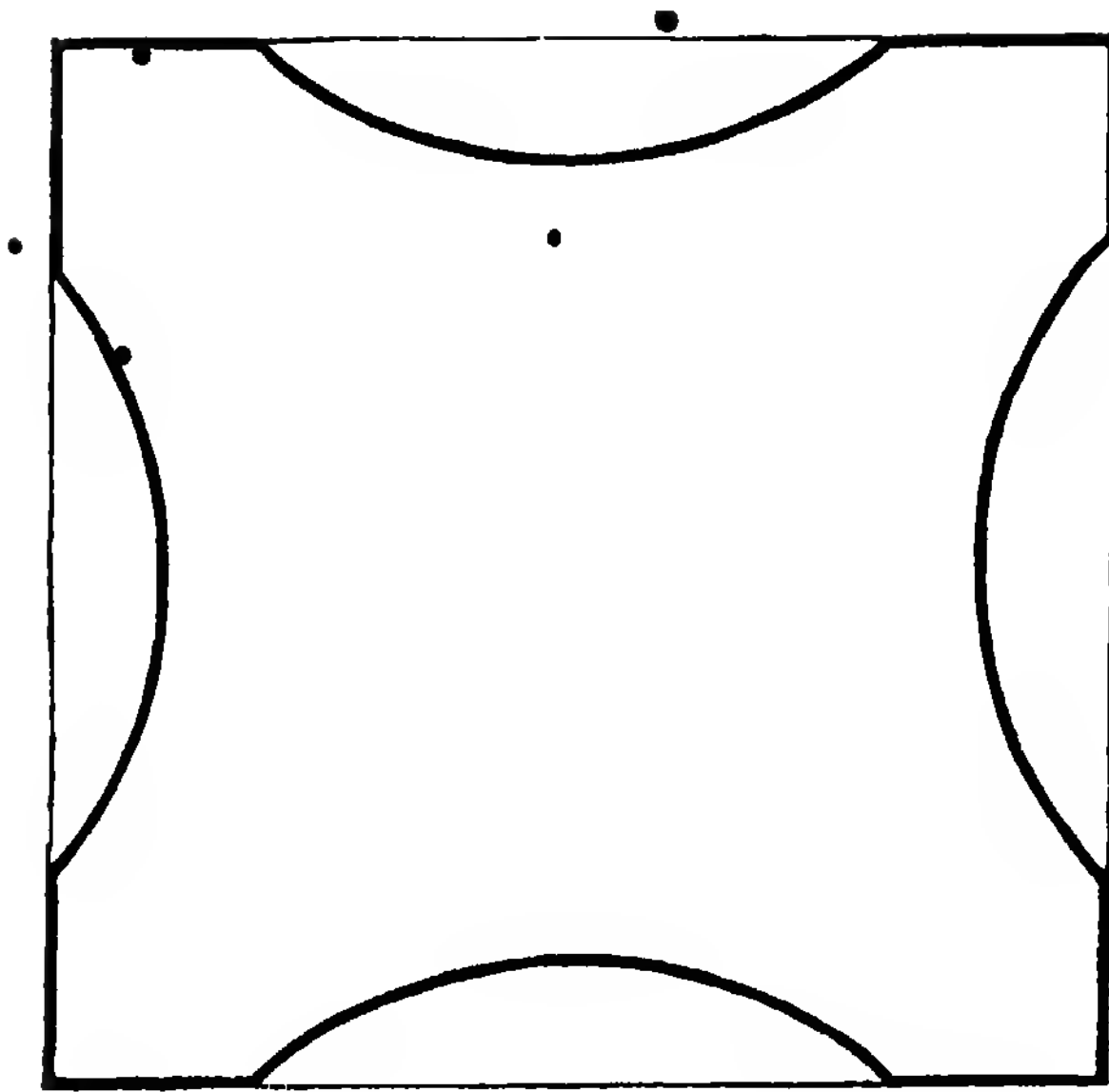
**MATERIALS.**—*Moist clay (somewhat less than in previous exercises); modelling board · small square wooden block · modelling tool; damp sponge.*

Flatten out clay on board, by help of small wooden block, to form a good square slab.

Mark on the clay with the modelling tool fine lines joining the middle points of the sides of the square.

Mark with tool symmetrical curved lines (see figure) on sides of square from near its corners.

Cut out with the tool the pieces enclosed by the curved lines, and neatly finish off the figure.



**Exercise XXII.****CLAY MODELLING.**

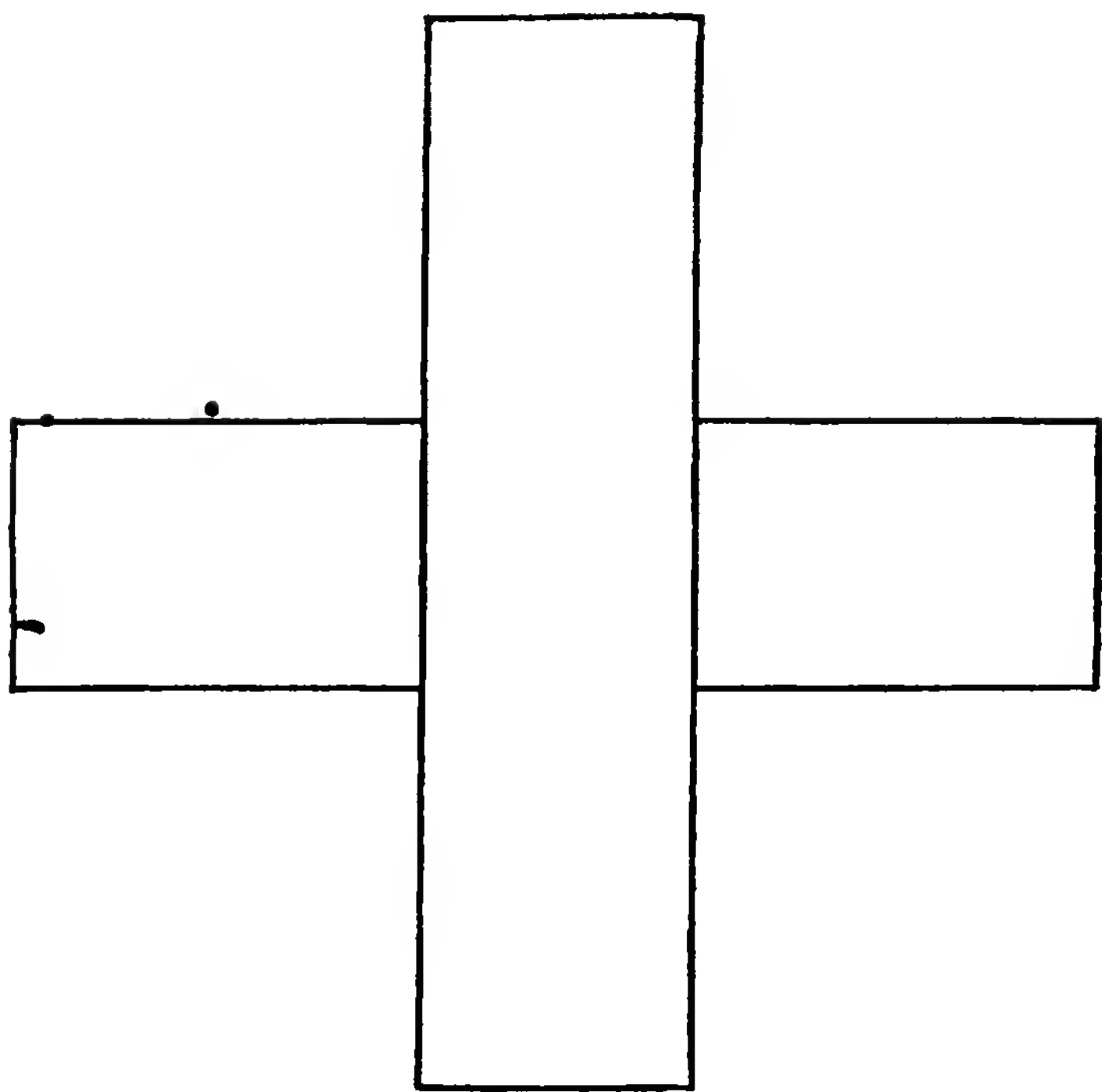
**MATERIALS.**—*Moist clay (about same quantity as in last exercise) ; modelling board ; modelling tool ; damp sponge ; rule ; small square wooden block.*

Divide clay into two approximately equal portions.

Make up each piece of clay into rectangular block 4" long and 1" wide, by help of small wooden block.

Lay pieces on board to form a cross with equal arms—using one block complete, and cutting pieces of proper length from the other block to form the side arms. (The latter pieces might have their ends moistened to make them adhere to the central strip.)

Measure distance from centre of cross to end of each arm, to see if all arms are equal.





**Exercise XXIII.****PAPER CUTTING AND MOUNTING.**

**MATERIALS.**—*Coloured gummed paper square ; model circular disc for pattern (or compasses, or string and drawing pin) ; lead pencil ; ruler ; damp sponge ; large white paper square ; scissors.*

Draw circle on back of coloured gummed paper square, either by tracing it round metal disc, or with pin and string or compasses.

Carefully cut out circle.

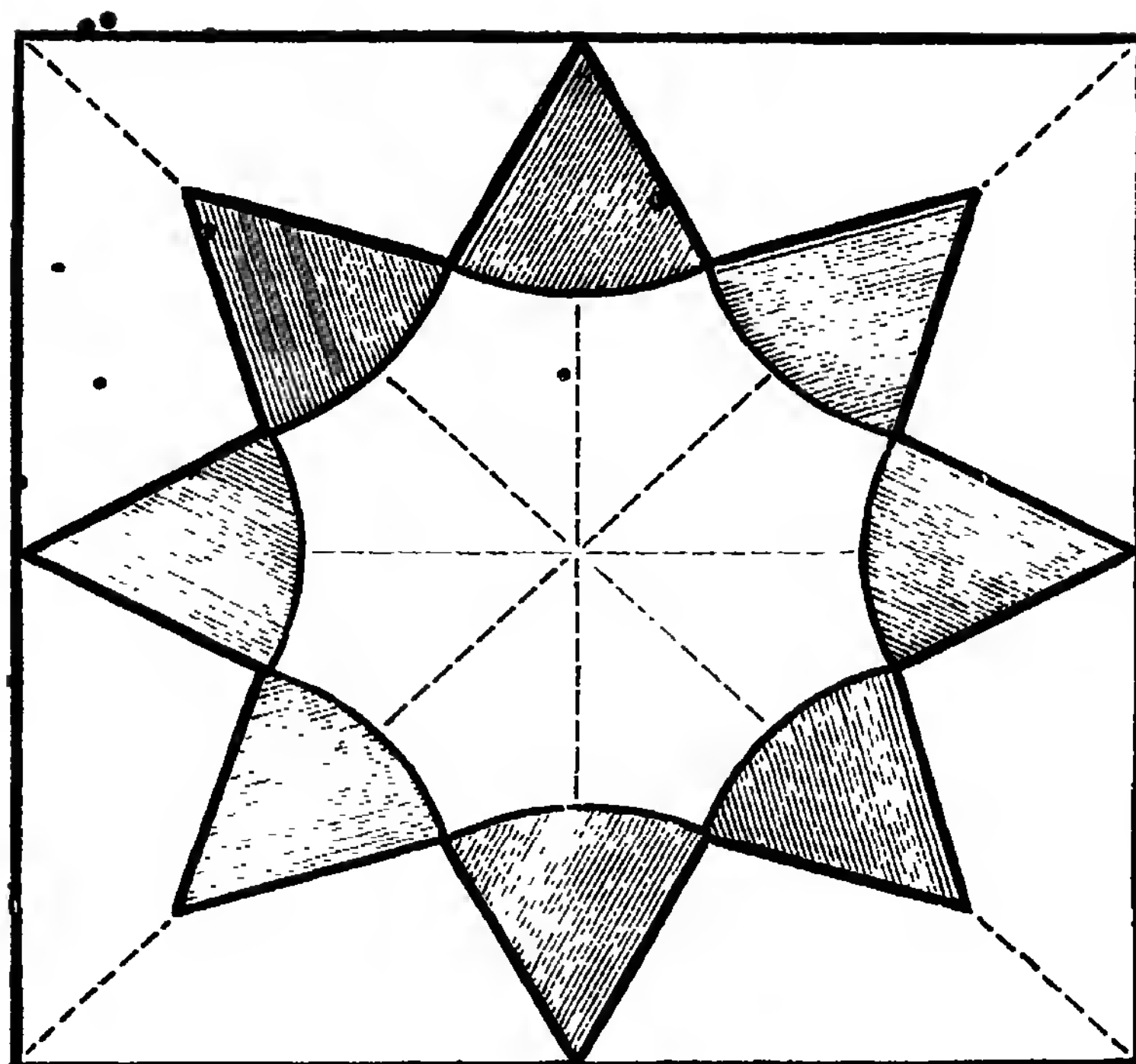
Fold paper circle along one diameter (coloured side inward), and then again at right angles, to form four quadrants ; crease well.

Cut out quadrants carefully along creased lines.

Fold each quadrant carefully along a radius into two equal parts ; crease well, and cut along creased line.

Rule faintly on white paper square the diagonals and lines joining middle points of edges.

With the eight coloured sectors lay the design as in figure (which should be drawn on the blackboard), and then mount.



**Exercise XXIV.****DESIGNING AND PAPER MOUNTING (PLATE III.).**

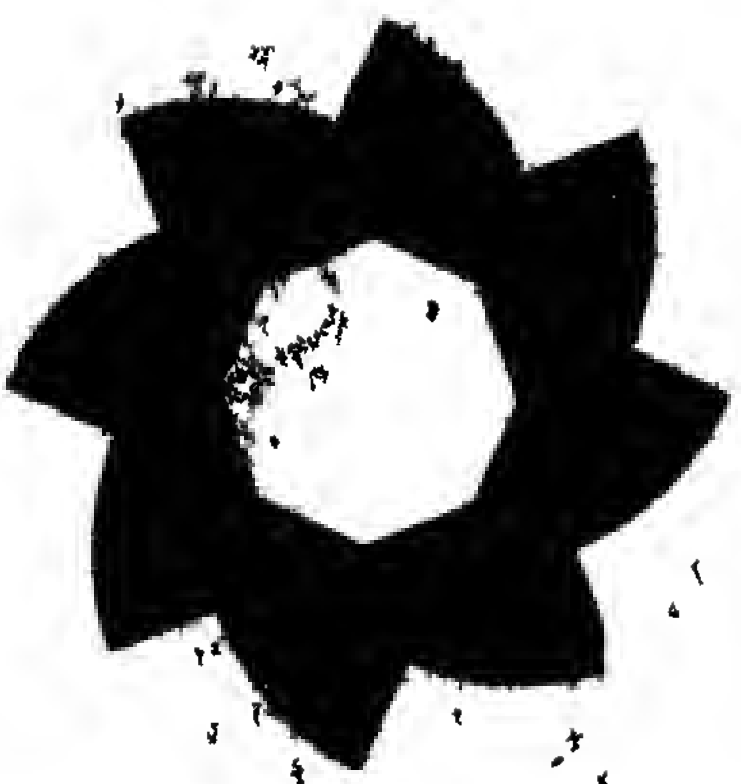
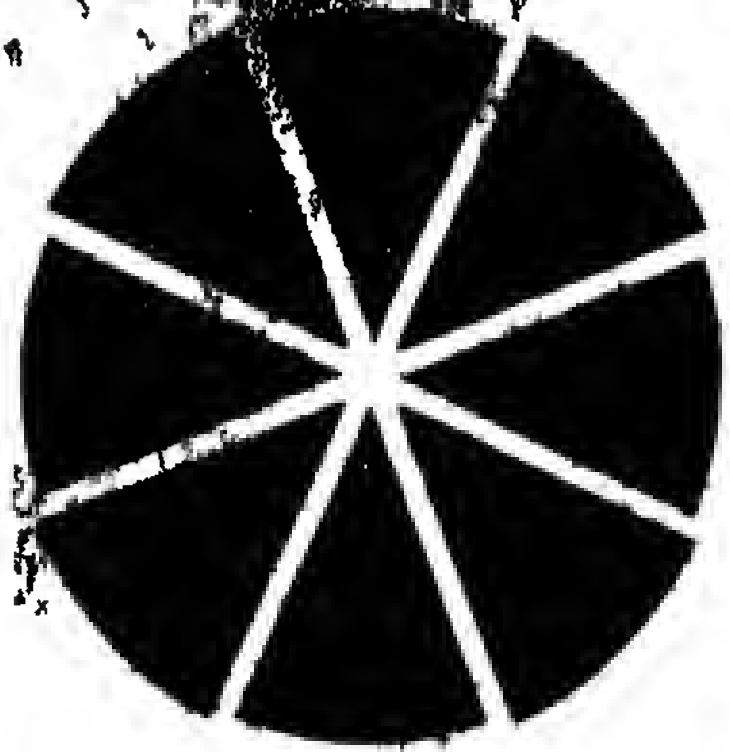
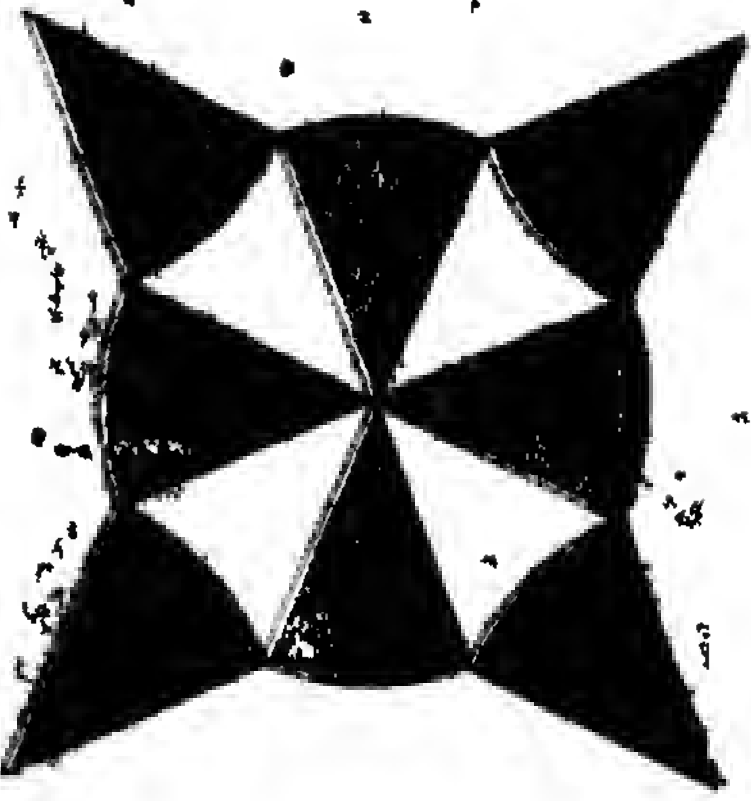
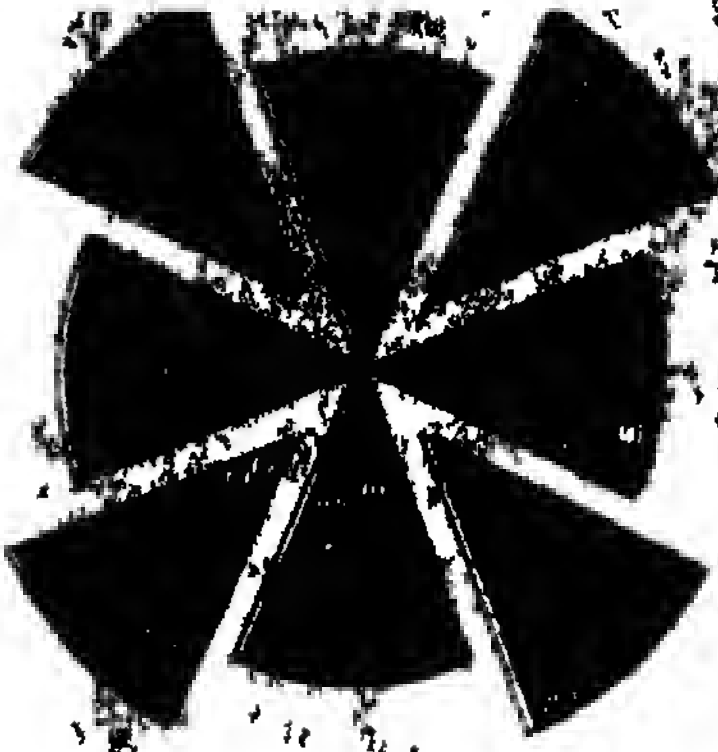
**MATERIALS.**—*Coloured gummed paper square; model circular disc (or string and drawing pin, or compasses); large white paper square; ruler; lead pencil; scissors; damp sponge.*

Outline circle on back of coloured gummed paper square; cut out circle, and divide into eight sectors, as in Exercise XXIII.

Children lay patterns of their own design with the eight sectors on white paper square.

Mount approved patterns (using faintly ruled diagonals and middle lines of square, if necessary, as guides in mounting).

[Various patterns formed with the sectors are given in Plate III.]







**Exercise XXV.****PAPER MODELLING.**

**MATERIALS.**—*Coloured gummed paper square ; cartridge paper (half-sheet) ; damp sponge ; rule ; lead pencil ; set square ; scissors.*

Measure coloured paper square.

Draw on cartridge paper a square having side  $\frac{1}{2}$ " shorter than coloured paper square.

Cut out the drawn square.

Moisten one face of the cut-out square with the damp sponge, and lay it on the gummed side of the coloured square, leaving a margin on *three* sides, as shown in Fig. 1. (Let children first lay square in position before damping, to see that they understand the directions.)

Cut with scissors along the short dotted lines shown at *a* and *b* in Fig. 1 ; fold the narrow projecting strips of coloured paper, *a d* and *b c*, over the cartridge paper square, and fasten them down.

Bend the stiff paper carefully into a cylindrical form, and fasten the projecting gummed flap so as to keep the edges together, to form an open cylinder (Fig. 2).

[A completed cylinder, previously made, might be shown to the children at the beginning of the lesson, as the object about to be constructed.]

FIG. 1.

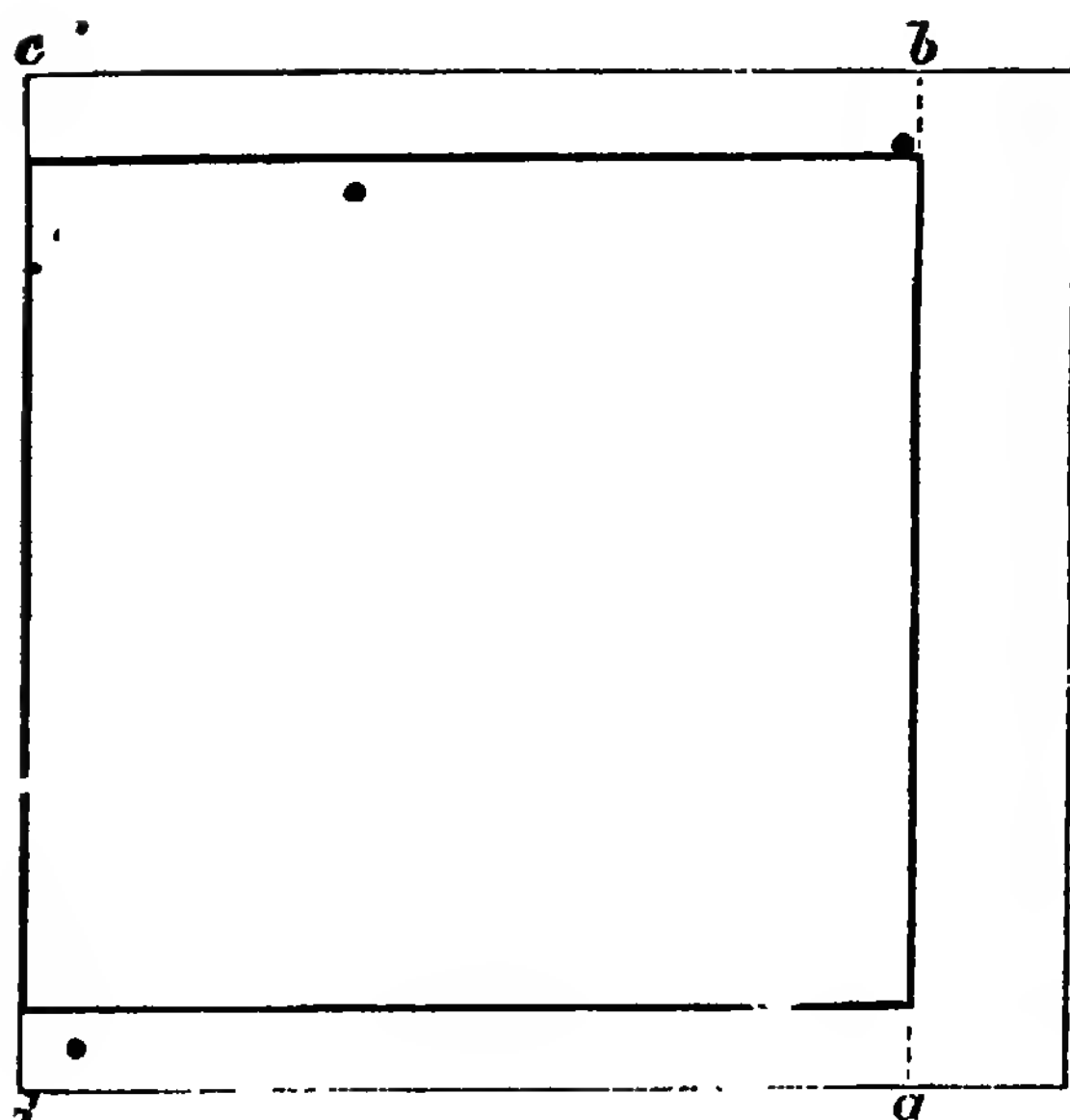
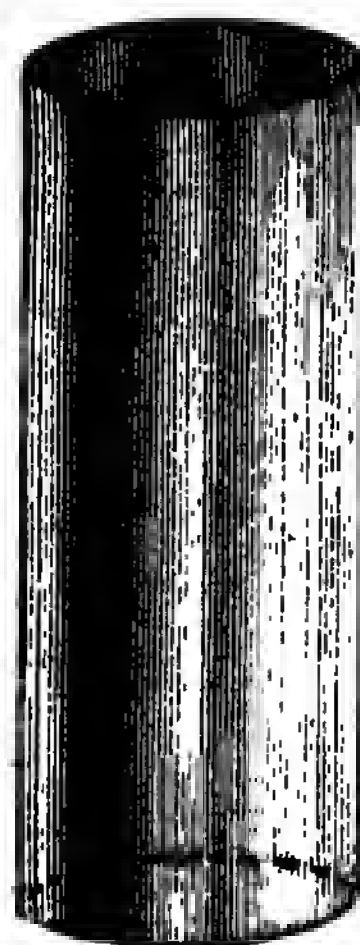


FIG. 2.





**Exercise XXVI.****PAPER MODELLING.**

**MATERIALS.**—*Cartridge paper (whole sheet) ; rule ; set square, lead pencil ; scissors ; small strips of gummed paper, about 2"  $\times$   $\frac{1}{2}$ " e.g., cut from gummed squares. [Paper cube, folded, but not fastened.]*

Show children paper cube previously prepared ; open it out to show a plan of its six equal square faces, and draw sketch of plan on blackboard (Fig. 1).

Children draw on cartridge paper, by means of rule and set square, the "net" (or plan) for cube with side 2" long. (Fig. 1 is not drawn full size, but the proper dimensions are marked.)

Cut round the *outside* lines of the figure when drawn.

Crease the cut-out figure neatly and accurately along the uncut lines, and fold it so as to make a cube (Fig. 2).

The loose edges of well-made cubes might be fastened together by means of the gummed strips, which should be first creased lengthwise down the middle.

**NOTE.**—These exercises in paper modelling are intended rather to illustrate the principle of constructing solid forms from previously drawn plane figures, and to lead the children to observe the relations of the various faces bounding the solid form, than as exercises in the production of finished models.

FIG. 1.

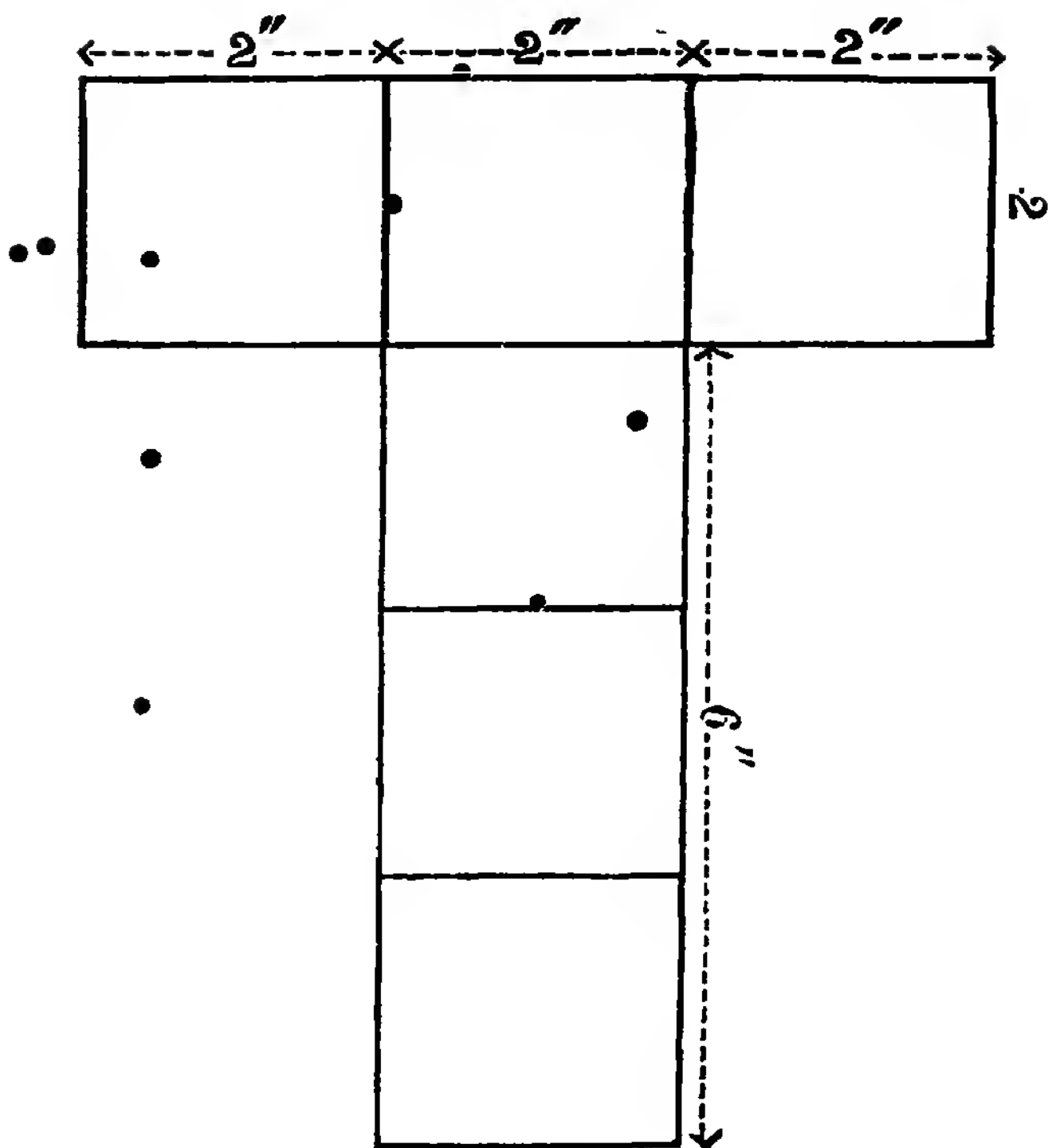
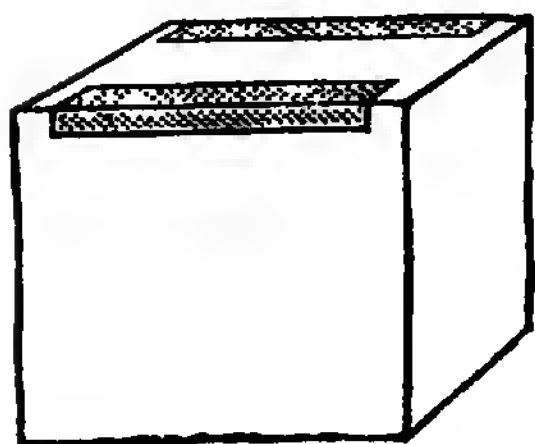


FIG. 2.



**Exercise XXVII.****PAPER MODELLING.**

**MATERIALS.**—*Cartridge paper (whole sheet) ; rule ; set square ; lead pencil ; scissors ; gummed paper strips. [Prism of stout paper, folded, but not fastened.]*

Show children the square prism previously prepared, and open it out to show its six faces.

Draw on blackboard the "net" for such a prism (Fig. 1).

Children draw on cartridge paper, to proper dimensions, net for square prism, having long sides 3", and short sides  $1\frac{1}{2}$ ".

Cut round the *outside* lines of the figure.

Crease the cut-out figure neatly and accurately along the pencilled lines, and fold together to form the prism (Fig. 2).

The loose edges of well-made prisms might be fastened with the gummed strips.

FIG. 1.

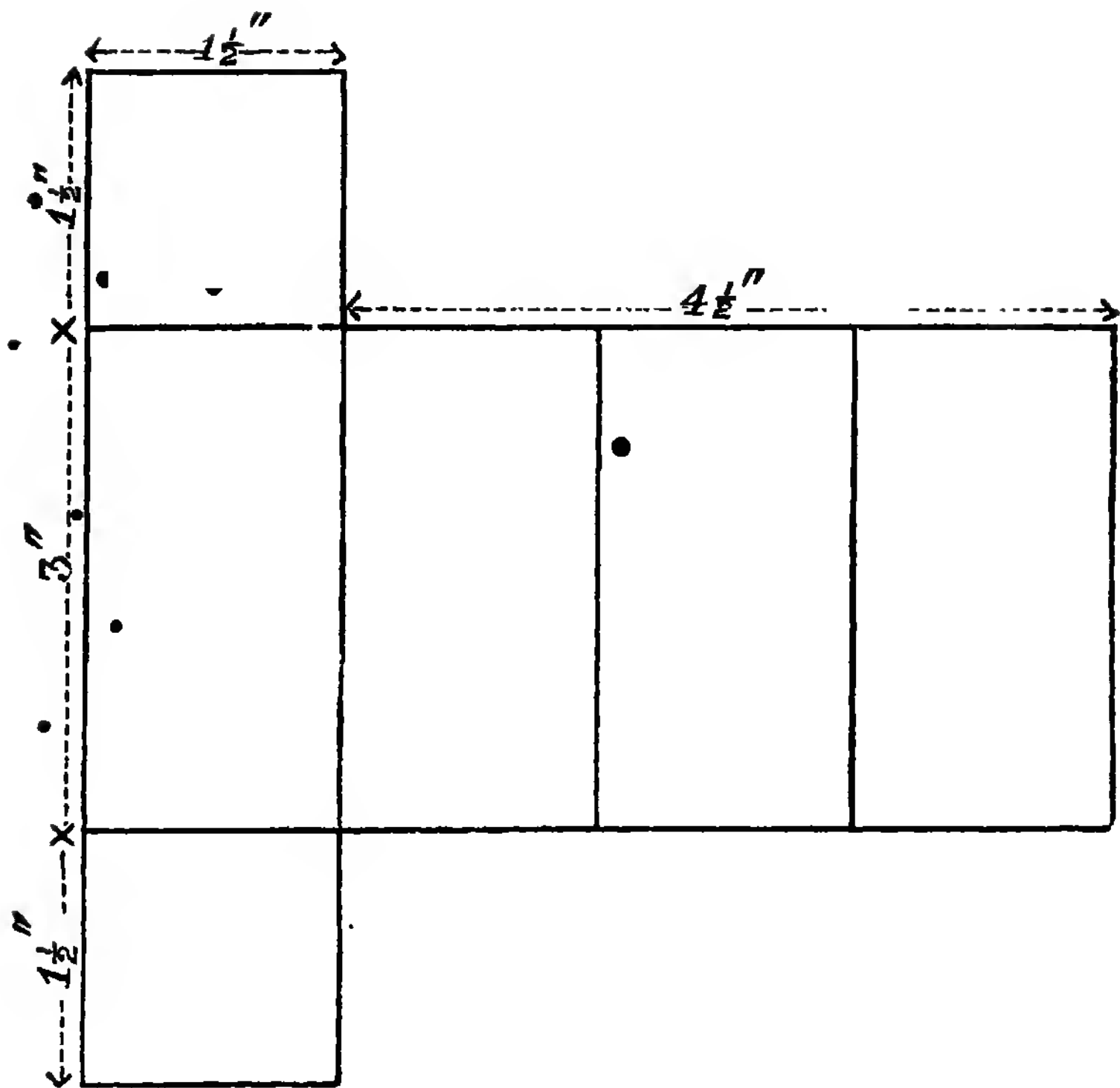
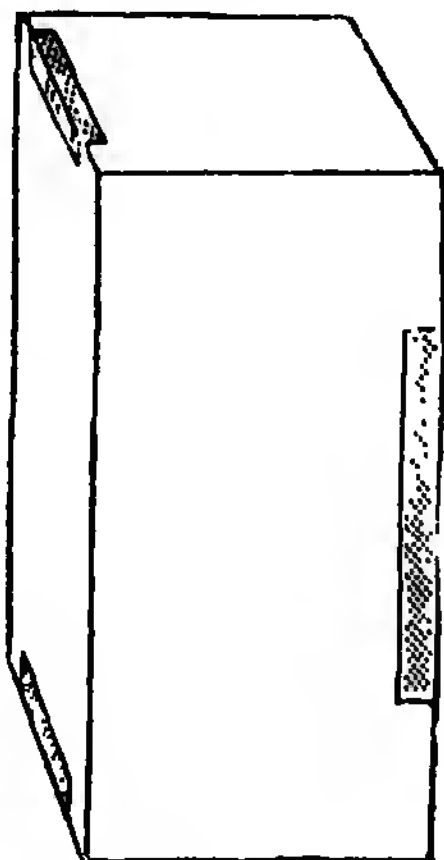


FIG. 2.



**Exercise XXVIII.****PAPER MODELLING.**

**MATERIALS.**—*Cartridge paper (half-sheet); lead pencil; rule; set square; scissors; gummed paper strips. [Triangular prism of stout paper, folded, but not fastened]*

Open out previously prepared model prism, to show its five faces.

Draw on blackboard the “net” for such a prism (Fig. 1).

Children draw on cartridge paper, to proper dimensions, net for triangular prism having long sides 3", and short sides  $1\frac{1}{2}$ ". (Draw the equilateral triangles by means of the set square with angle  $60^\circ$ .)

Cut round the *outside* lines of the figure.

Crease the cut-out figure neatly and accurately along the pencilled lines, and fold together to form the prism (Fig. 2).

The loose edges of well-made prisms might be fastened with gummed paper strips.

FIG. 1.

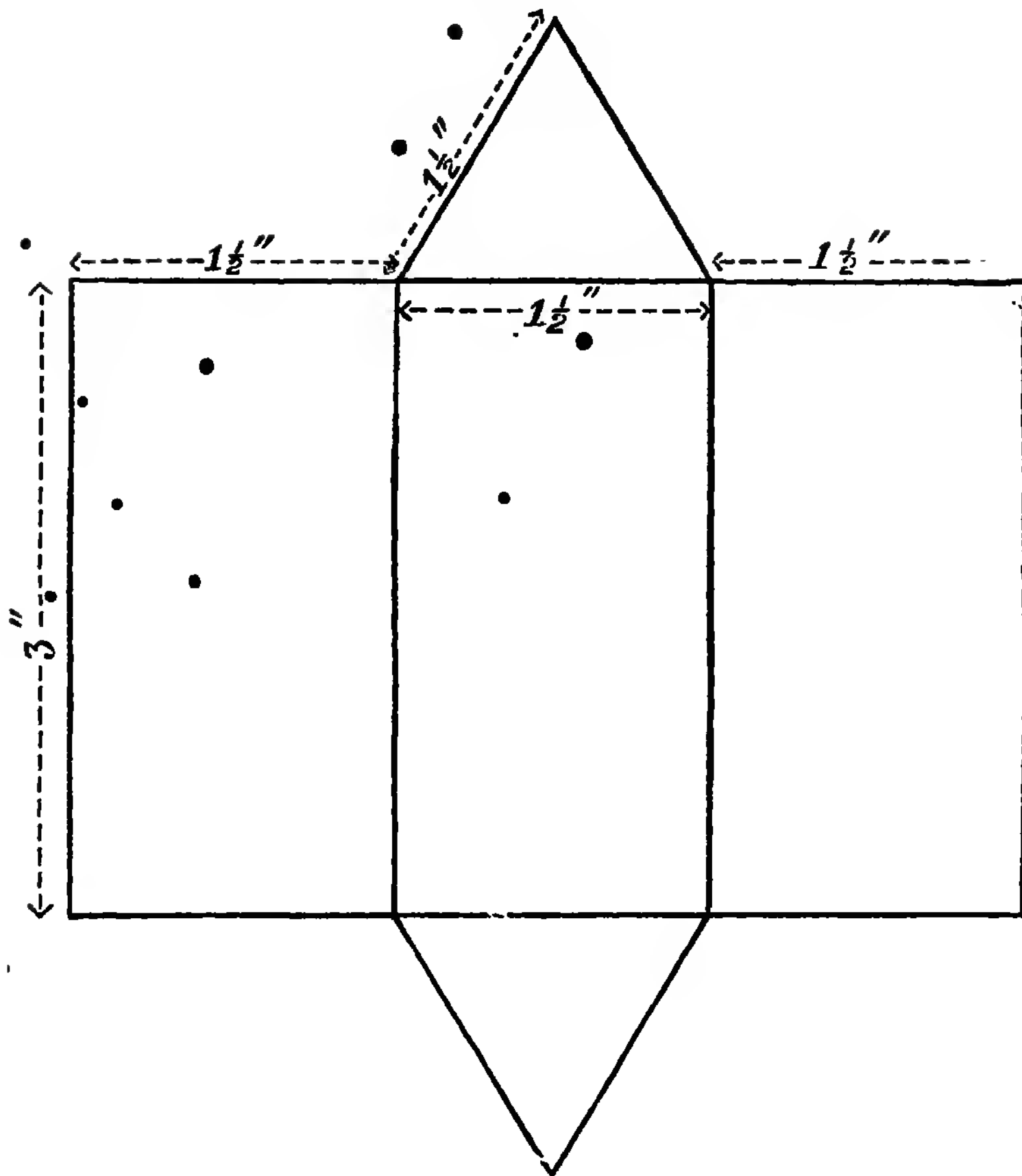
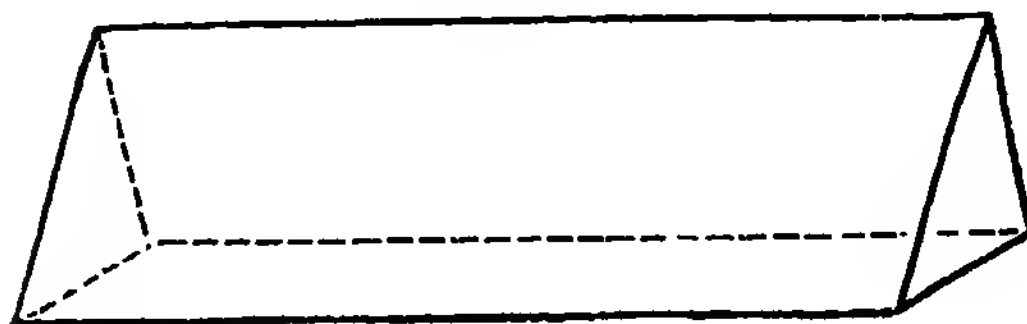


FIG. 2.



**Exercise XXIX.****DRAWING CIRCLE AND ELLIPSE.**

**MATERIALS.**—*Cartridge paper (whole sheet); sharp lead pencil; thin string about 10" or 11" long; ruler; two drawing pins; scissors.*

Tie small loop at each end of string, leaving length between loops about 6" or 7".

Put drawing pin through both loops, and fasten down through estimated middle point of paper; then with point of pencil in doubled part of string trace out a circle (Fig. 1).

Rule two diameters of circle at right angles to each other by estimation.

On other side of cartridge paper construct ellipse as follows:—

Rule line lengthwise at about middle of paper (Fig. 2, *a b*). ‘

Mark on this line its estimated middle point, and also points at equal distances (say about 2") on each side of it (Fig. 2, *c* and *d*).

Fasten drawing pin through loop of string at each of two latter points, and with point of pencil in angle of string (kept tight) trace out half-ellipse. Then lift string over pins, and trace out other half of ellipse.

Rule the axes of the ellipse, and note inequality.

Cut out the ellipse, and compare its form with that of a circle.

FIG. 1.

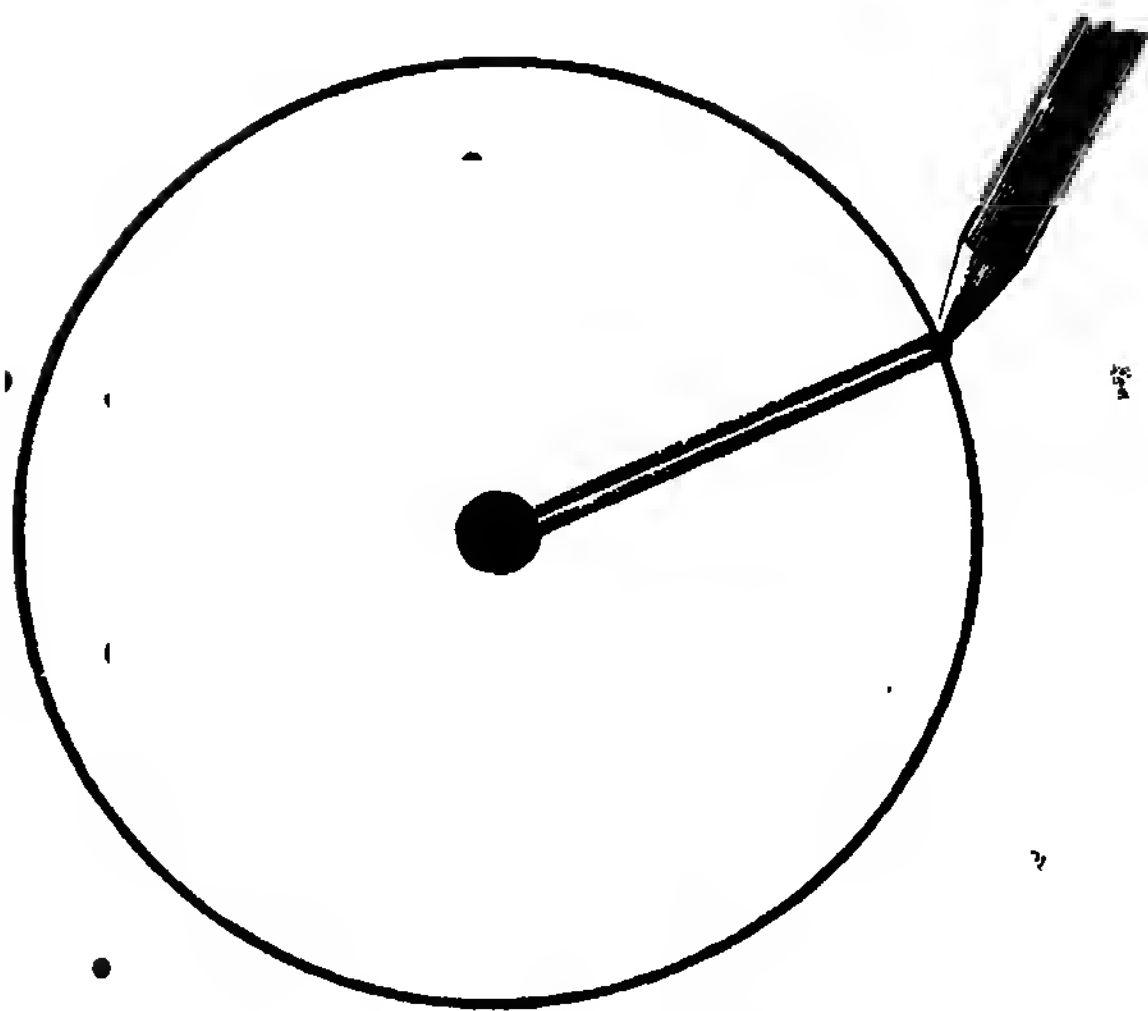
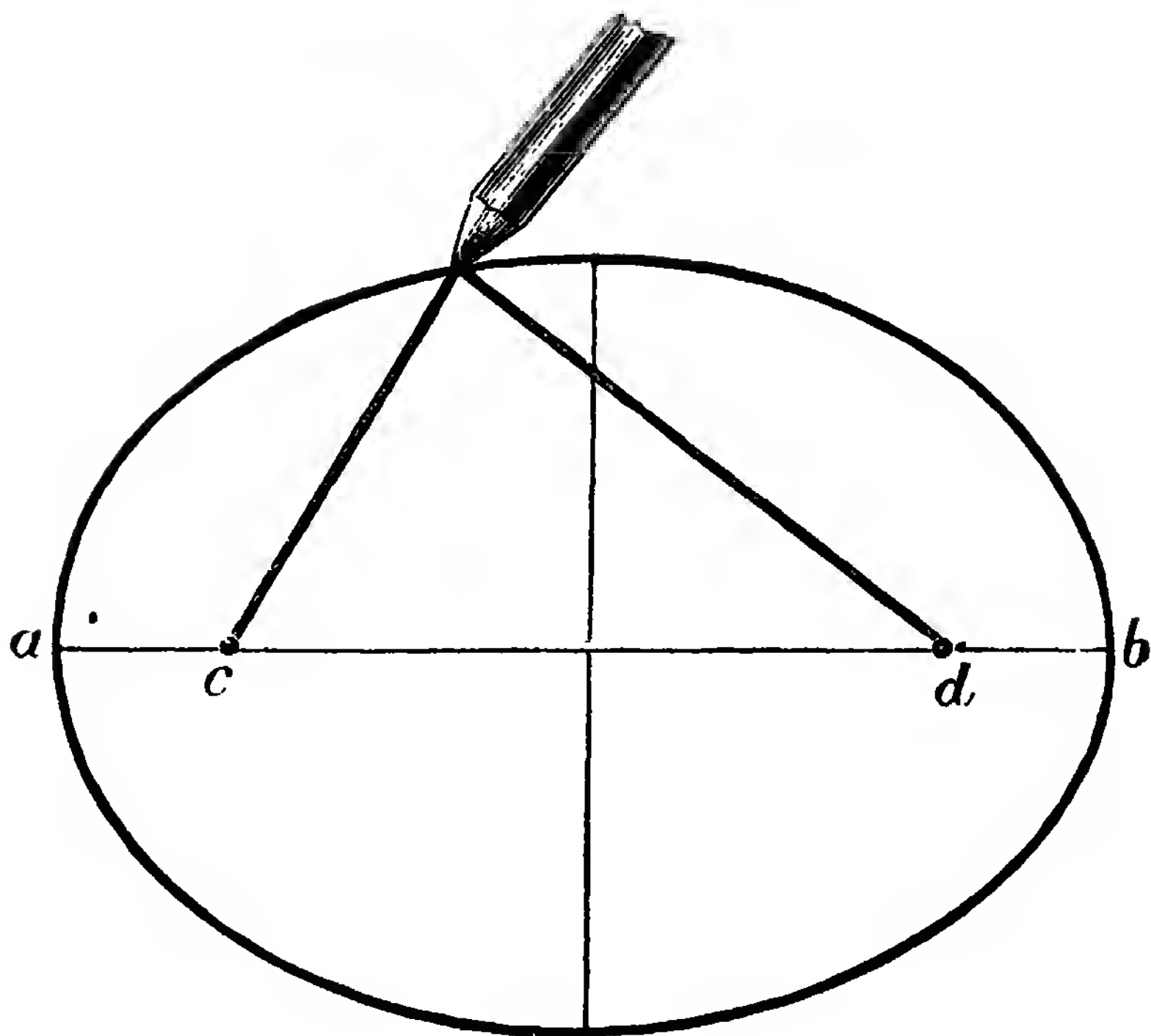


FIG. 2.





**Exercise XXX.****PAPER CUTTING AND MOUNTING.**

**MATERIALS.**—*Coloured gummed paper square ; large white paper square ; damp sponge ; ruler ; lead pencil ; model circular disc (or string and drawing pins, or compasses).*

Draw outline of circle (as large as possible) on back of gummed paper square.

Carefully cut out circle.

Fold circle carefully twice at right angles (Fig. 1).

Cut carefully along a line (by estimation, without previously marking) parallel to curved edge of folded paper (e.g. the inner curved line of Fig. 1).

Open out the cut-off strip of paper, to show it is a circular ring.

Cut straight the (cut) edge of the folded paper (see dotted line in Fig. 1), and open out to show it is a square.

Rule faintly diagonals of white paper square, and mount ring and square symmetrically, as in Fig. 2.

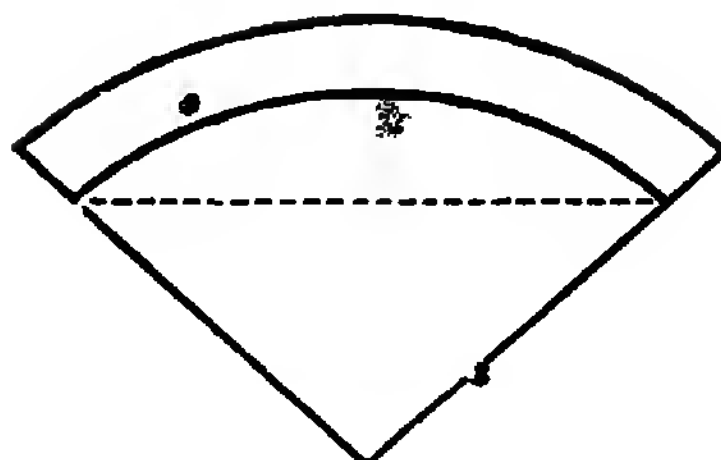
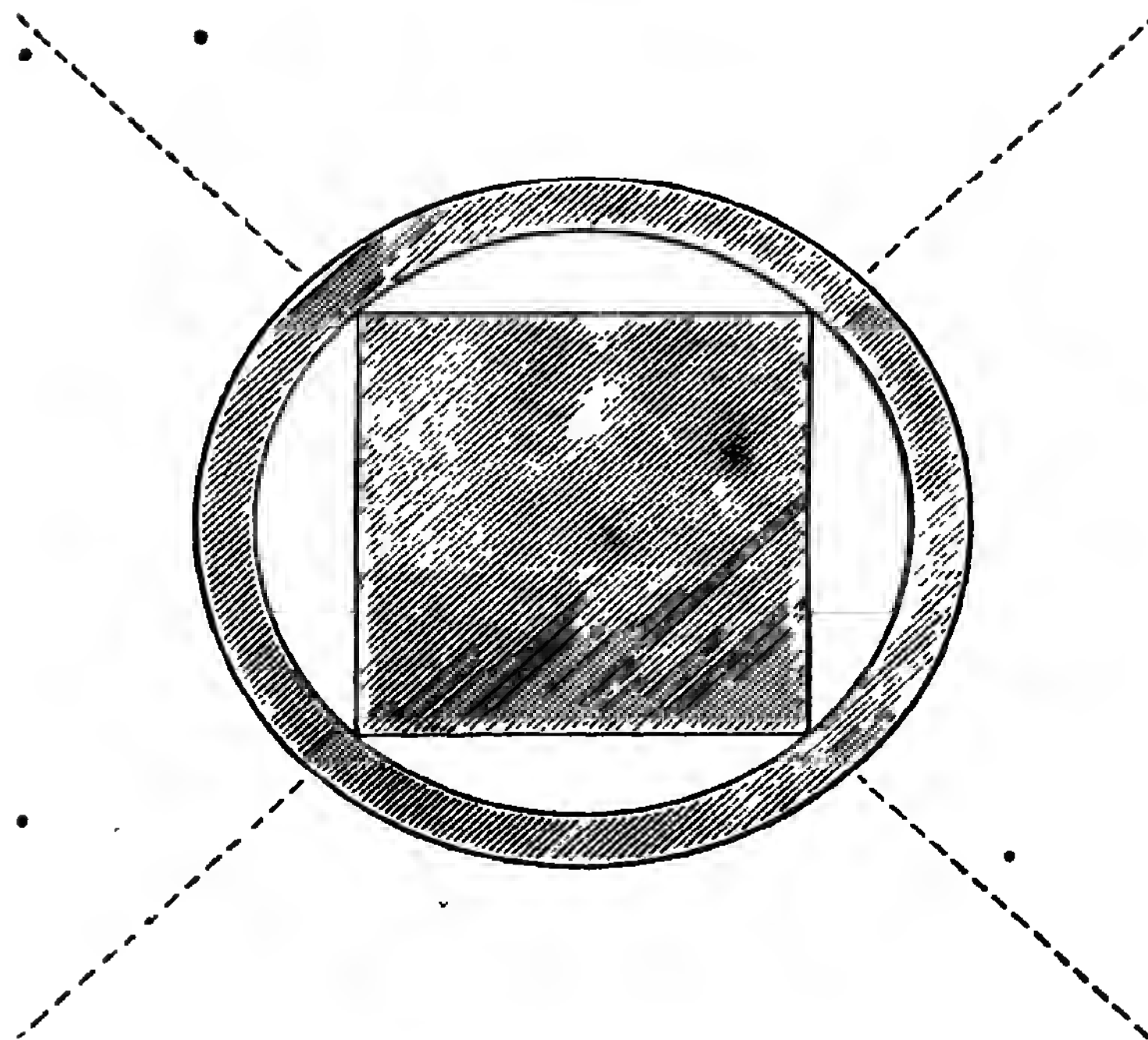


FIG. 2.





## FOURTH SERIES.



## • LIST OF APPARATUS AND MATERIALS.

[Those marked with \* are the same as used in an earlier series.]

• Iron wire, pieces 1 foot long. (*Note K*, p. 130.)

Small flat pliers. (*Note L*, p. 130.)

Cardboard, in pieces  $12'' \times 8''$ ,  $8'' \times 6''$ , and  $6'' \times 4''$ . (*Note M*, p. 190.)

• Board for cutting cardboard on (same as used for clay modelling).

Small cutting knife. (*Note N*, p. 190.)

Steel rule for use in cutting. (*Note O*, p. 191.)

Gummed strips of bookbinder's cloth, about 1' long,  $\frac{1}{2}''$  wide. (*Note P*, p. 191.)

Drawing paper (some plain, and some divided into squares • of  $\frac{1}{8}''$ ).

Compasses (with pencil leg).

Set square, with angles  $60^\circ$  and  $30^\circ$ .

Rule, marked to eighths.

Stout brown paper envelopes. (*Note Q*, p. 192.)

## NOTES ON THE APPARATUS AND MATERIALS, AND THEIR USE.

The notes on the apparatus and materials which follow the list for the Third Series, as well as those in connection with the lists in Part I., should be consulted.

(*M*) *Cardboard*.—The cardboard must not be so stout as to make it very difficult for the children to cut it with the knife; but at the same time it should be stiff enough to enable it to keep its shape without bending. It should also not be such as to break off short when being bent in the modelling exercises. The cardboard suggested for use in the following exercises is “four-sheet mounting board,” which the children should be able to cut with a proper knife without much difficulty. (It will be necessary, however, for them to draw the knife two or three times across the cardboard, in order to make a clean cut.)

Cardboard tinted on both sides—Caledonian or Granite grey, for example—is recommended in preference to white, as not being so readily soiled.

The sizes of the pieces used in the following exercises are such as can be cut with little waste from “royal” sheets (*i.e.* sheets measuring about 24"  $\times$  19"). It is best to get them cut with a bookbinder's guillotine.

(*N*) *Small cutting knife*.—A special knife, with short, stout pointed blade about 2" long, will be found the best for use in cutting the cardboard. The handle, about 4" long, should be rounded, and of such a size that it can be grasped firmly and comfortably by the hand of an ordinary child. (Messrs. Philip, Son, and Nephew supply special knives of the kind described.)

In cutting the cardboard the point of the blade should be used, the knife being held at a high angle, and kept close to the rule which is used to guide it along the



proper line. The rule must be held firmly in position by the fingers of the left hand.

(O) *Steel rule.*—A wooden rule must not be used for guiding the cutting knife, as the edge of the rule itself would be cut. Flat steel rules, 1" broad and 12" long, may be obtained at the tool-shops; but Messrs. Philip supply special steel rules 6" long, which are more easily held in place by the children. It is scarcely necessary to add that both the knives and rules must be kept in a dry place to keep them from rusting.

(P) *Strips of bookbinder's cloth* are used for binding over the edges of the cardboard—in the case of the flat cardboard figures merely to give them a more finished appearance, but in the case of the models either to join adjacent cut edges or to strengthen those where the cardboard is partly cut through.

The cloth is fastened on with gum or thin liquid glue, and for class purposes it is best to buy it ready gummed on one side and cut into strips. A piece of cloth of the length of the edge to be bound is cut from the strip, folded carefully lengthwise down the middle (to enable it to be placed symmetrically over the edge), then moistened, placed on the cardboard, and held in position until it adheres firmly.

Cloth of various colours may be obtained, and with the surface smooth or variously marked. Dark blue cloth, with a surface roughened by points or cross-lines, looks



very well on the grey cardboard, but the colour is apt to run if moistened too much.

- (Q) *Stout brown paper envelopes* are very convenient, one being given to each child to contain its pieces of cardboard, either when finished or in cases where an exercise has to be left before it is quite completed.

## EXERCISES IN WIRE MODELLING.

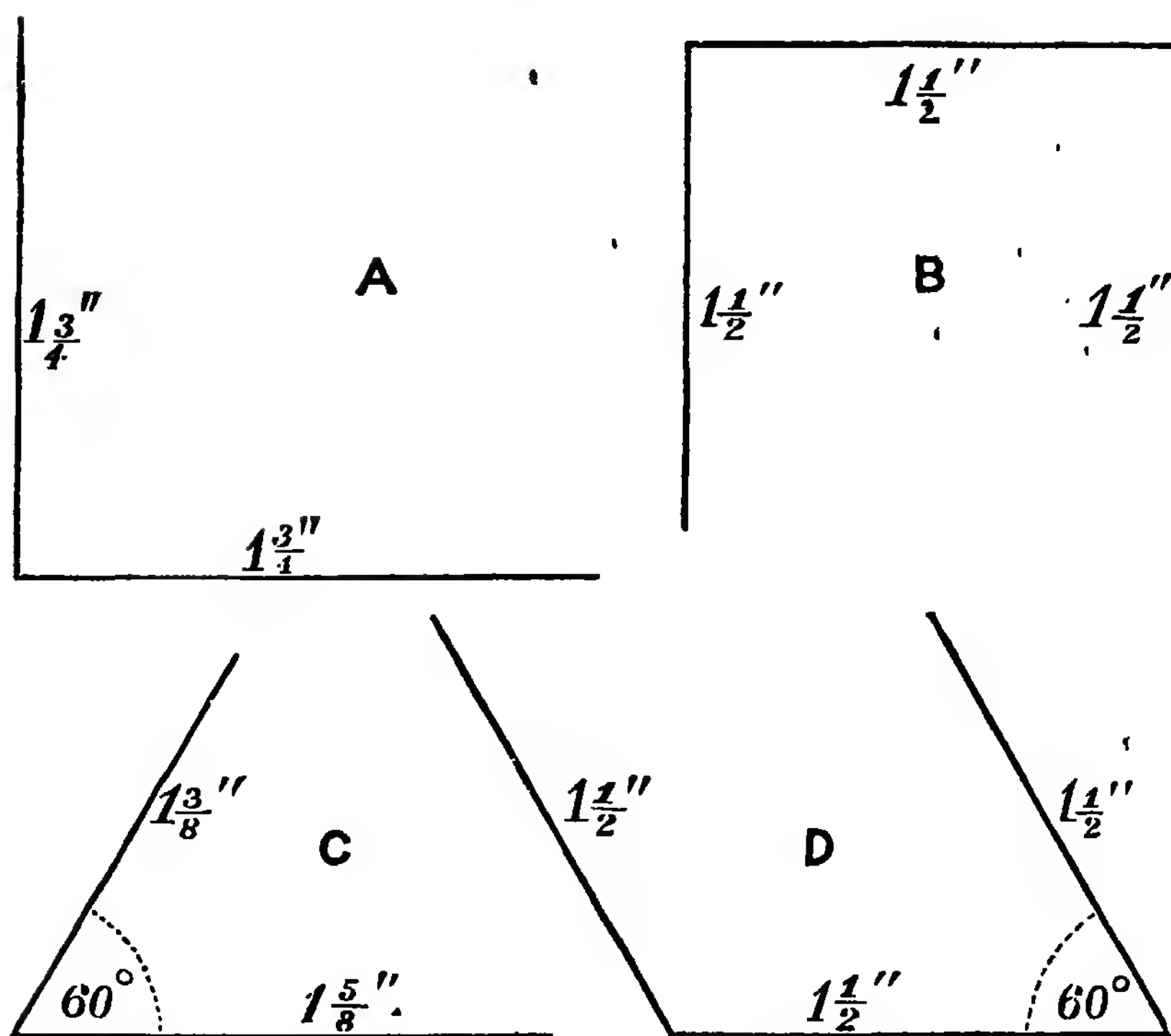
(EXERCISES I.—X.)

The first set of exercises in this series has for its object the construction of geometrical forms in fairly stout wire, by means of small flat pliers. (See *Notes K* and *L*, p. 130.)

The forms to be constructed are first drawn accurately to scale by the children, on paper (either plain or squared), from a sketch on the blackboard having the dimensions marked. Each child should have his copy before him when constructing the figure in wire.

The wire may, perhaps, need to be first straightened out. The distances on the wire must then be accurately measured, and the bends carefully made at the proper points as sharply as possible. Care must be taken in bending the wire to see that all the parts when bent are as nearly as possible in one plane, so that the wire will lie *flat* on the paper over the drawn copy.

As the materials required, and the method of work, are very nearly the same for all the exercises in this set, it is not necessary to add a full description of each separate exercise. The diagrams are drawn full size, with the dimensions marked. A single piece of wire 12" long is sufficient for each child, except in one or two exercises where two such pieces are required.

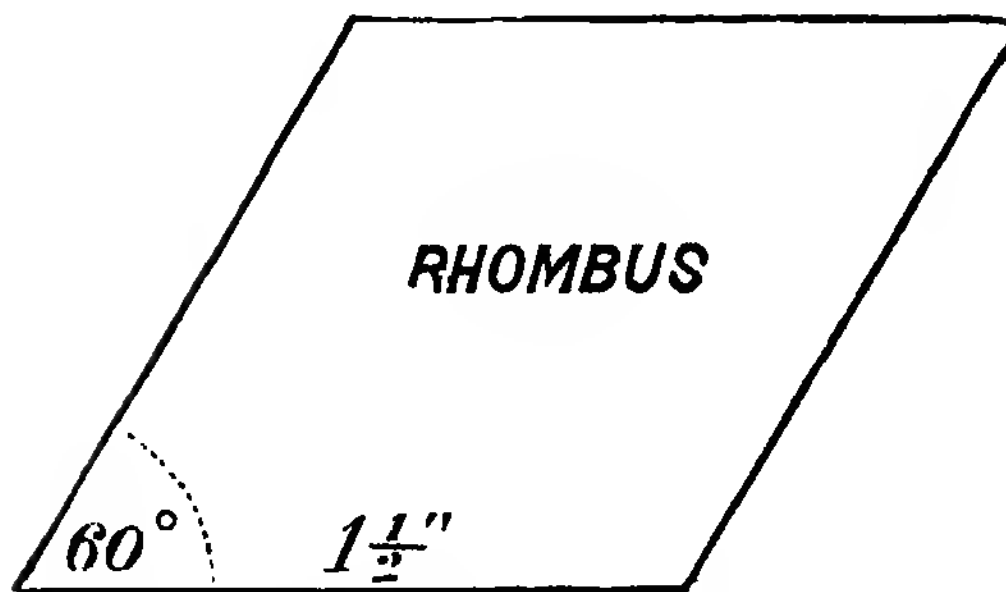
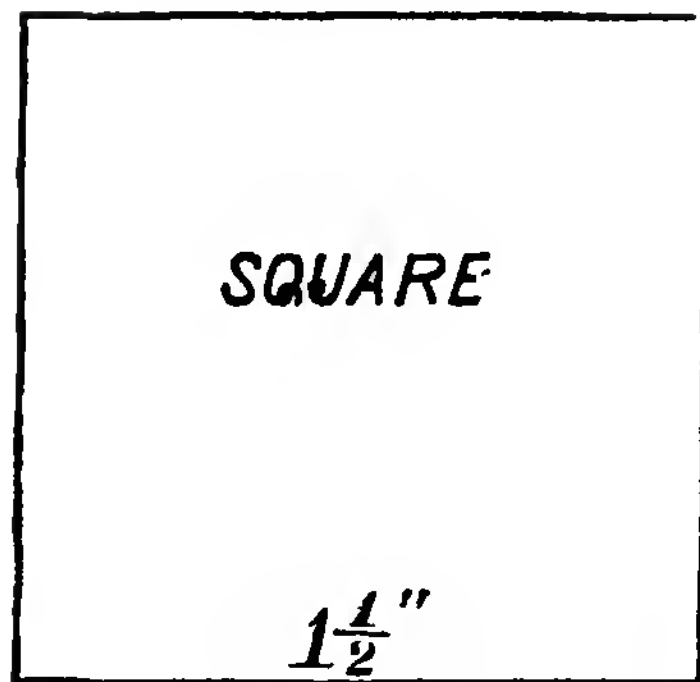
**Exercise I.****WIRE MODELLING.**

NOTE.—Calculate length of wire required for Fig. A ; break off piece of proper length, and bend at right angles as shown. Then do the same for Figs. B, C, D.

(The angles in the drawings may be obtained by means of the set square.)

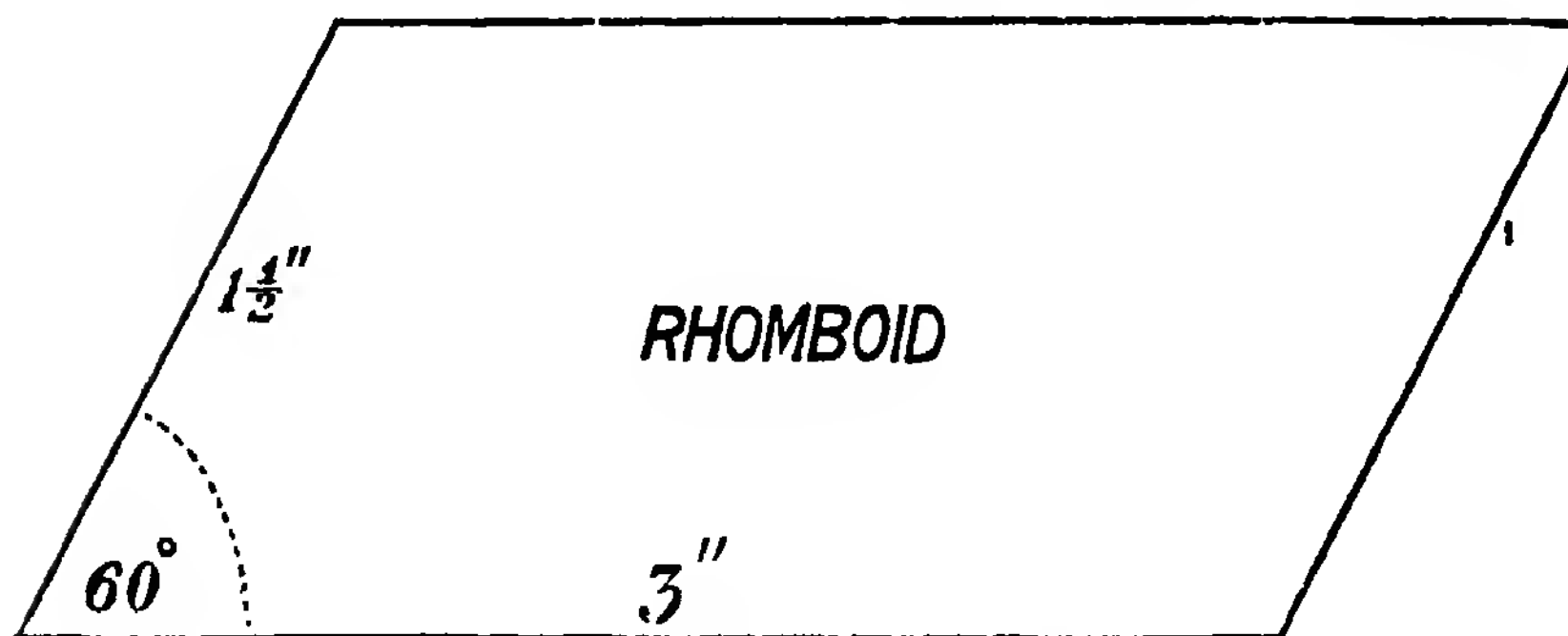
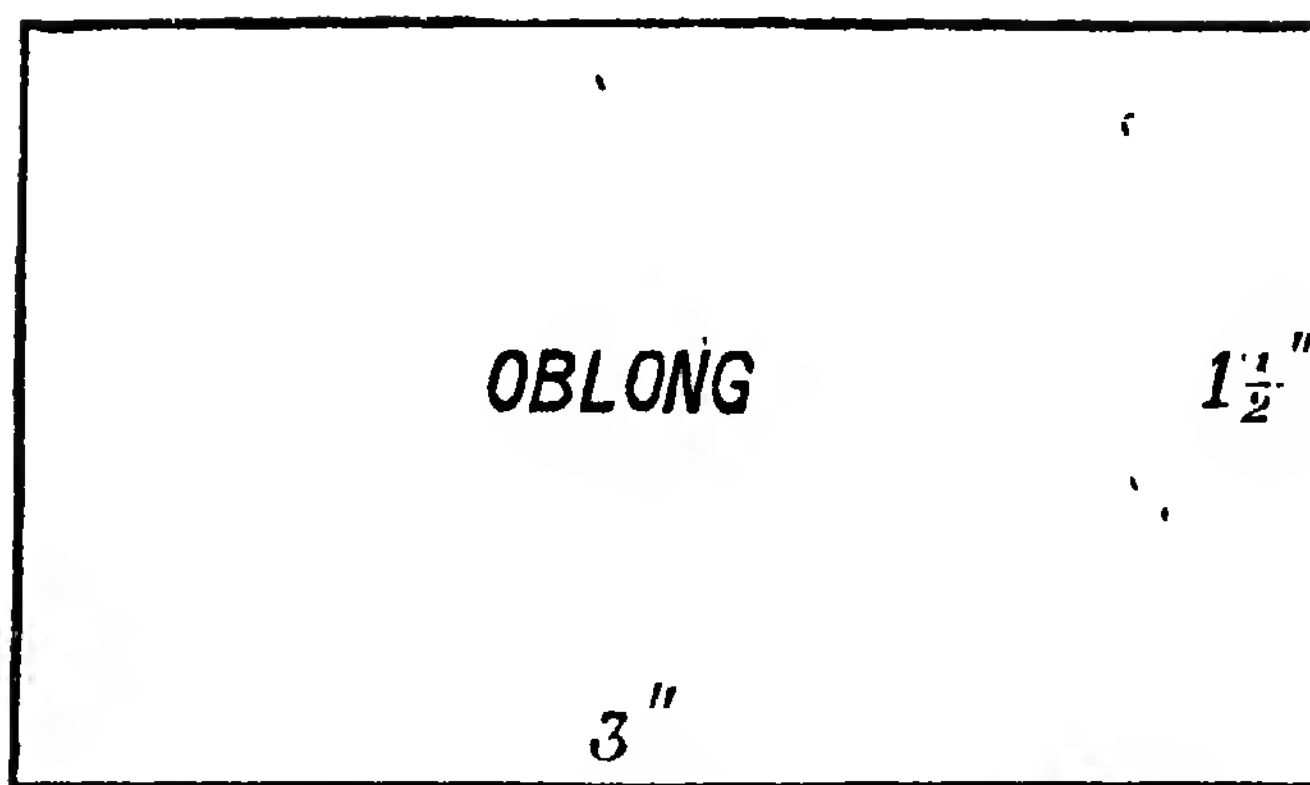
• **Exercise II.**

**WIRE MODELLING.**



**NOTE.**—Calculate length of wire required for each figure ; break wire into lengths required, and construct figures.

Afterwards convert each wire figure into the other ; *i.e.* the square into the rhombus, and *vice versa*.

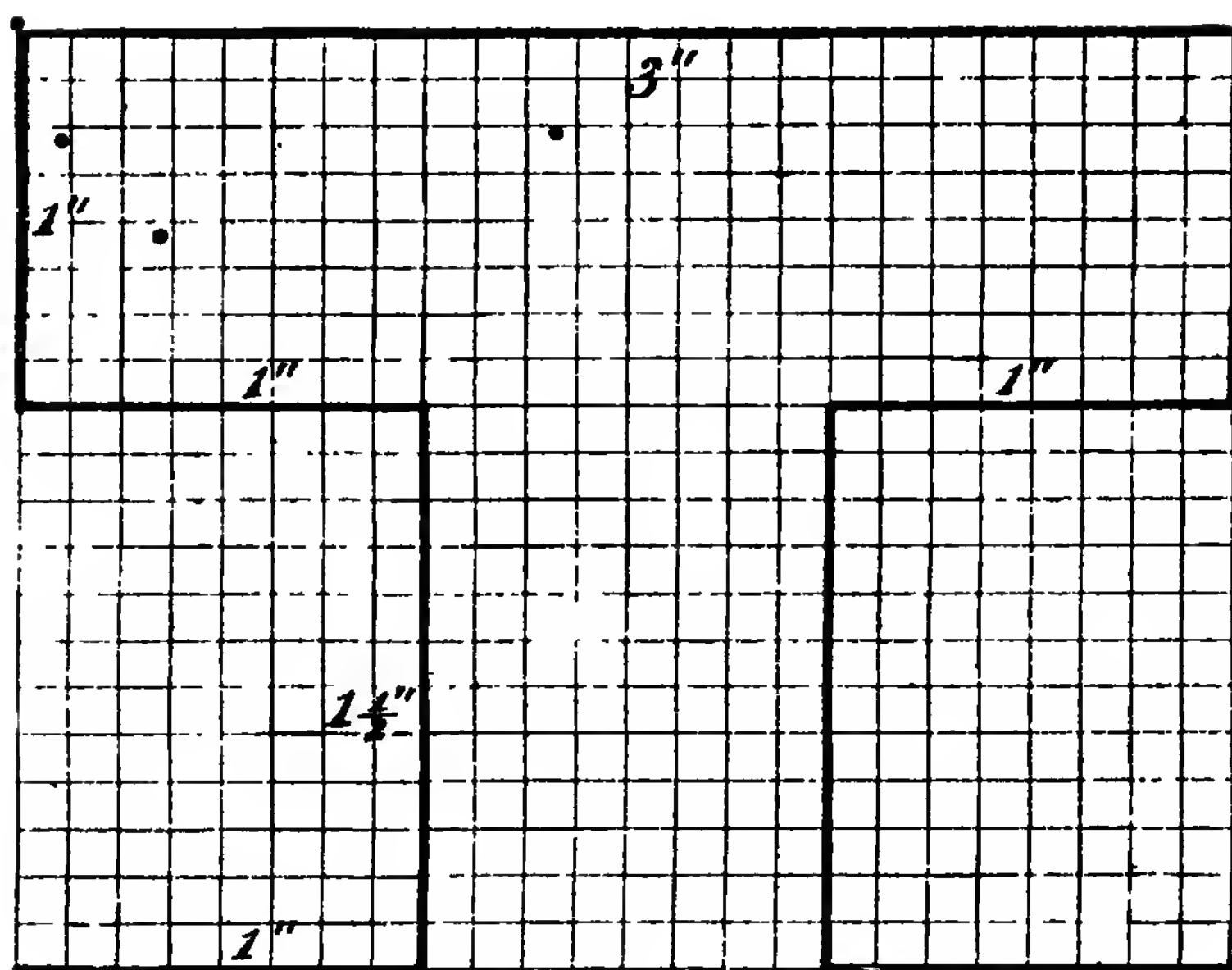
**Exercise III.****WIRE MODELLING.**

**NOTE.**—Two pieces of wire are required for this exercise. Calculate length required for each figure, and break off.

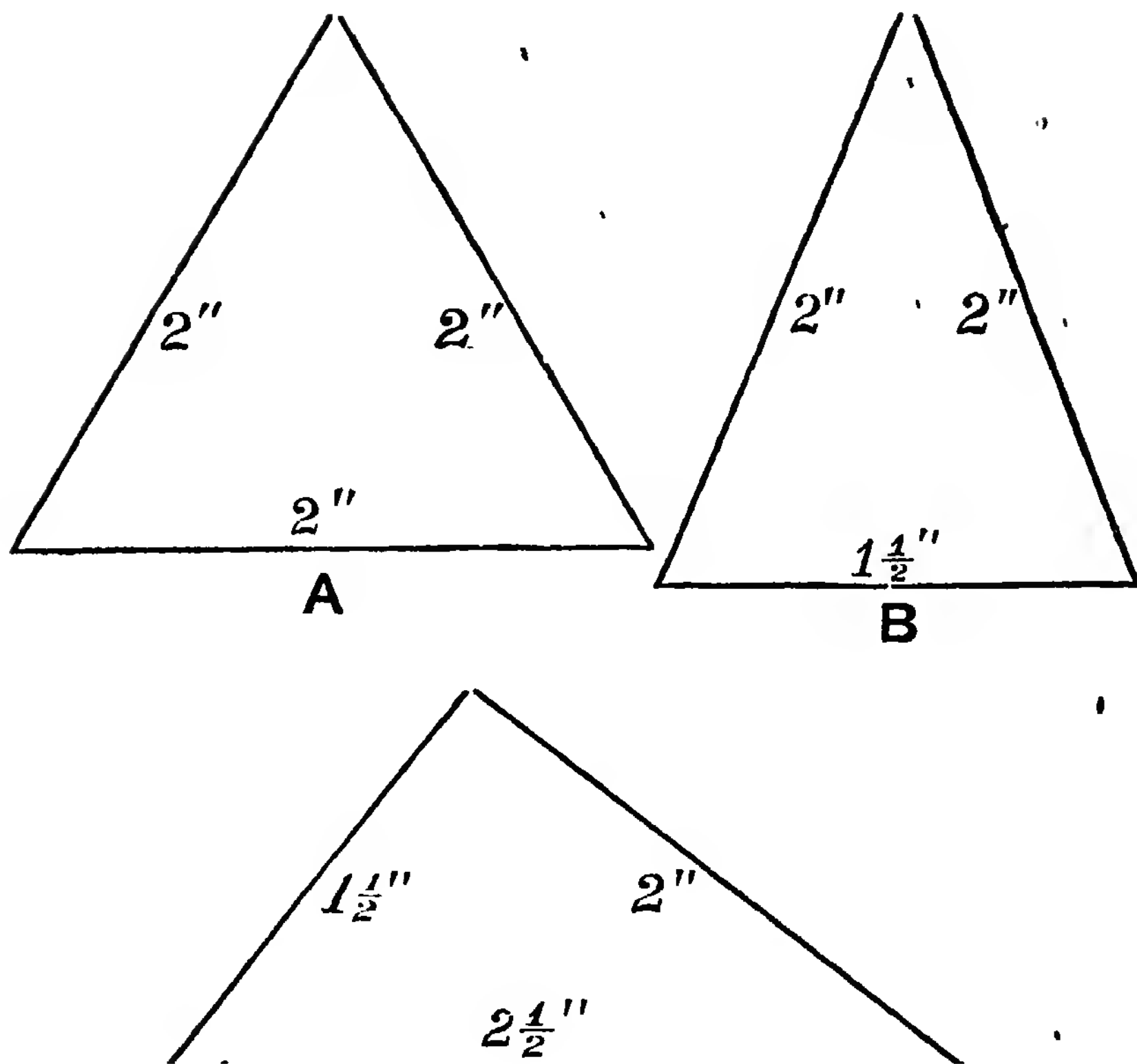
After constructing figures in wire, convert each into the other, as in the last exercise.

**Exercise IV.**

WIRE MODELLING.



NOTE.—This figure might be drawn on squared paper.

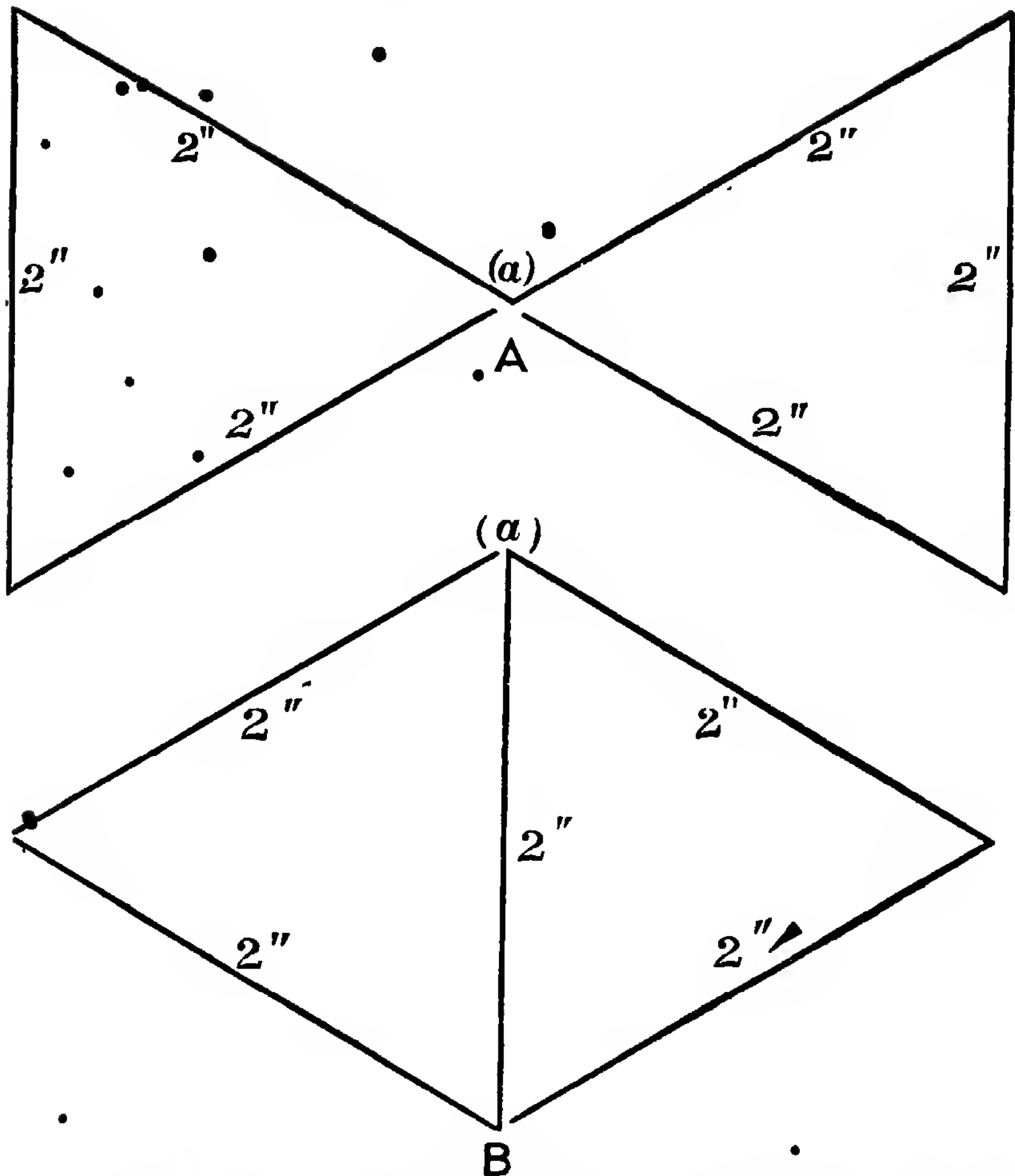
**Exercise V.****WIRE MODELLING.**

**NOTE.**—Draw the figures by means of rule and compasses.

*Two* pieces of wire are required.

## Exercise VI.

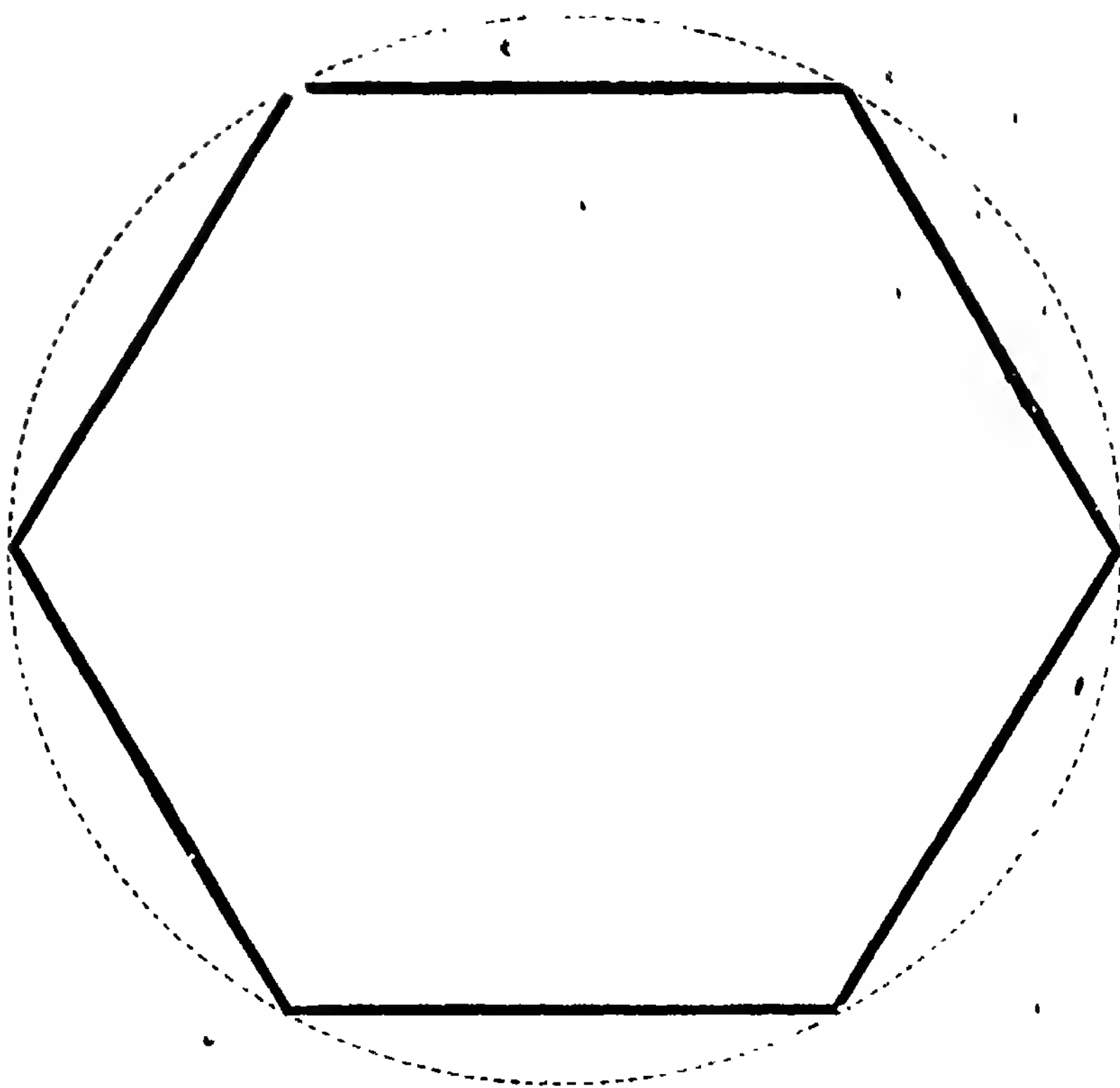
## WIRE MODELLING.



NOTE.—Draw one or both figures by means of compasses (or set square) and rule.

Two pieces of wire are required if each child constructs both forms. In constructing Fig. A, first find the middle point (a) of the wire, and commence bending there. For Fig. B the wire should first be broken to the proper length, then the position of point (a) found by measurement on the wire, and the bending commenced at that point.

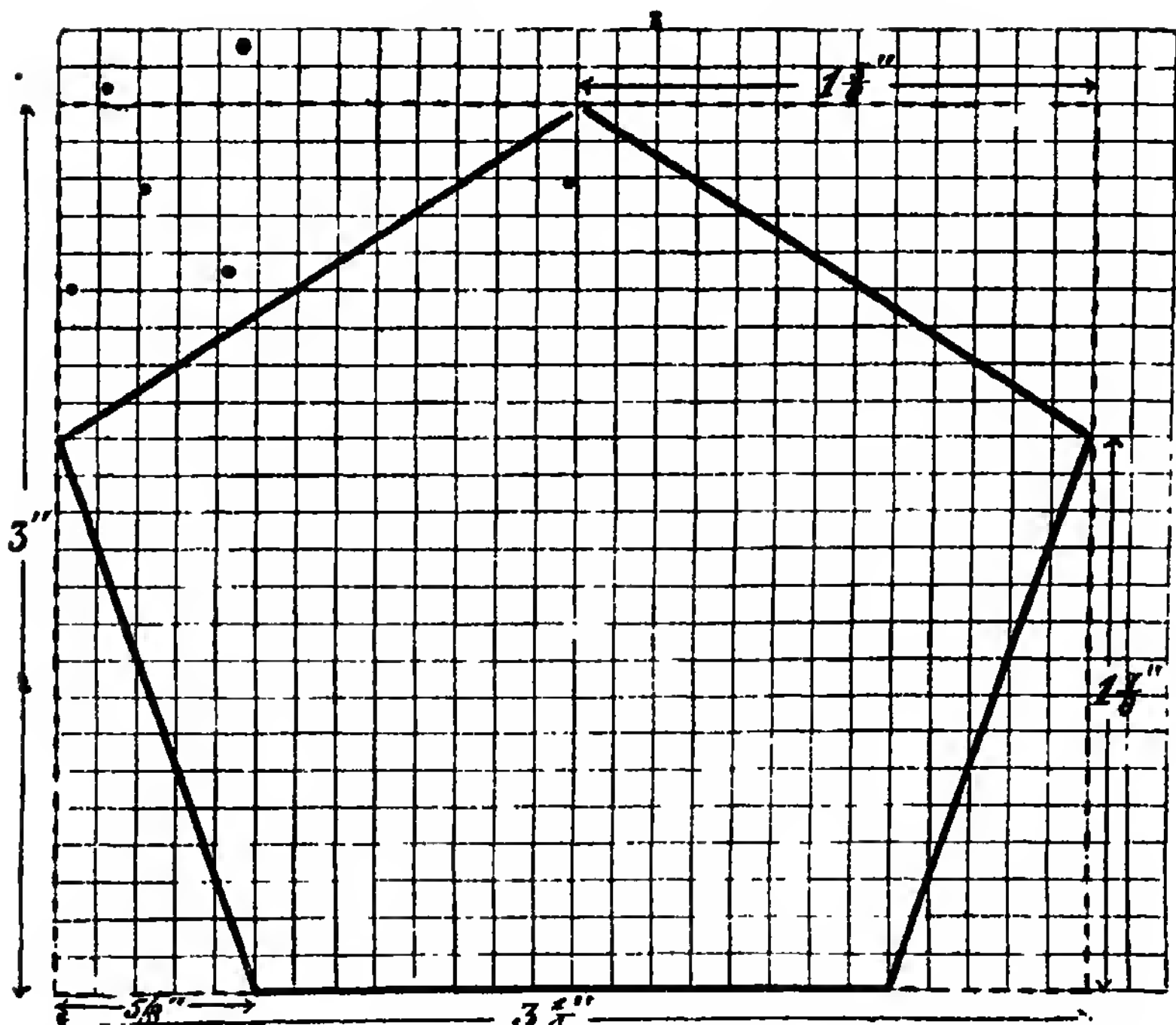


**Exercise VII:****WIRE MODELLING.**

**NOTE.**—Construct the hexagon in a circle by means of a pair of compasses.

• Exercise VIII.

WIRE MODELLING.

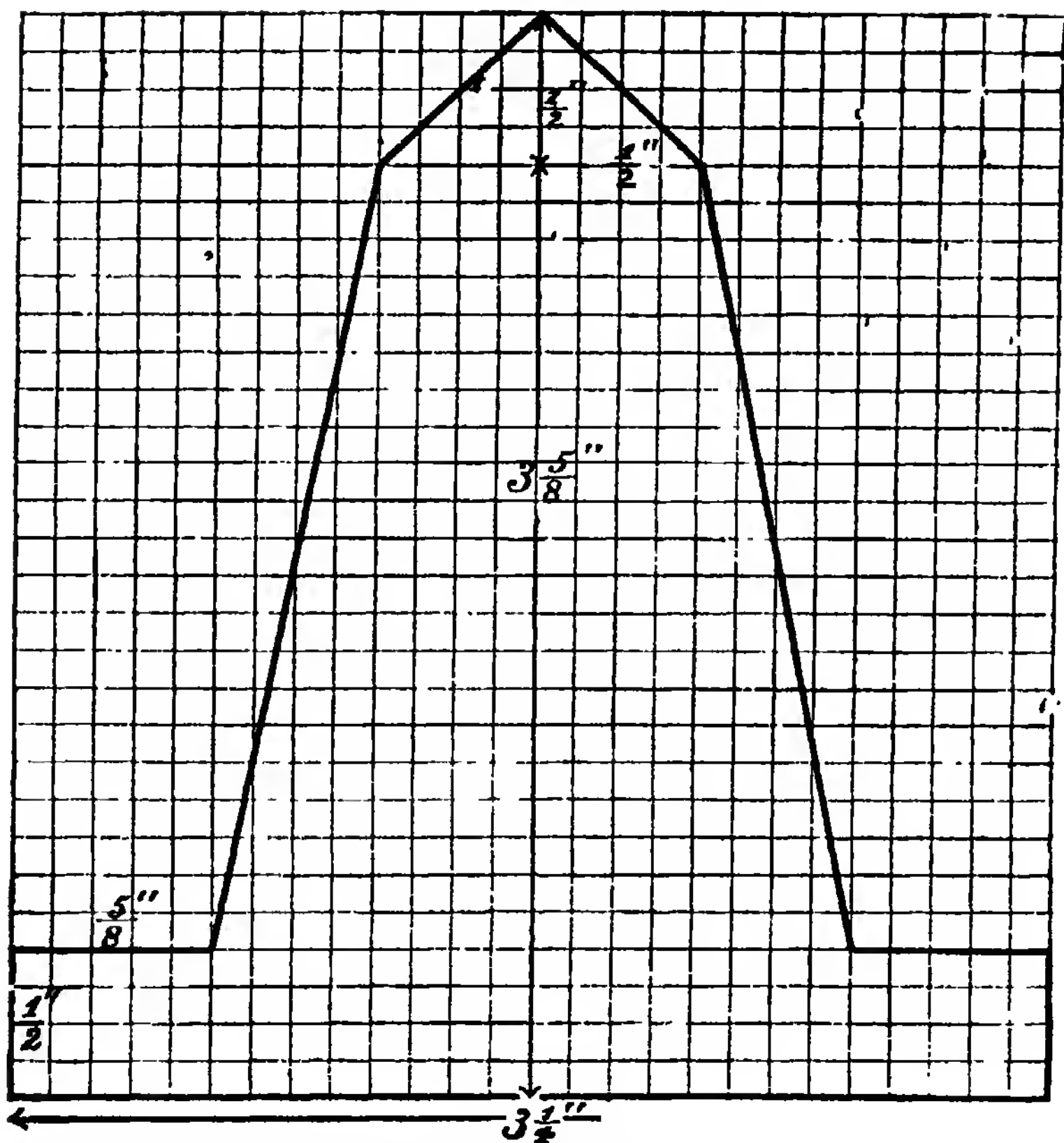


NOTE. The figure (pentagon) should be drawn on squared paper, as an exercise in drawing to scale—the rectangular figure (dotted) being first drawn, then the points on the sides found, and the pentagon constructed by joining the points.

Before constructing the figure in wire, the lengths of the sides must be measured, and the total length of wire required be calculated.

Exercise IX.

WIRE MODELLING.

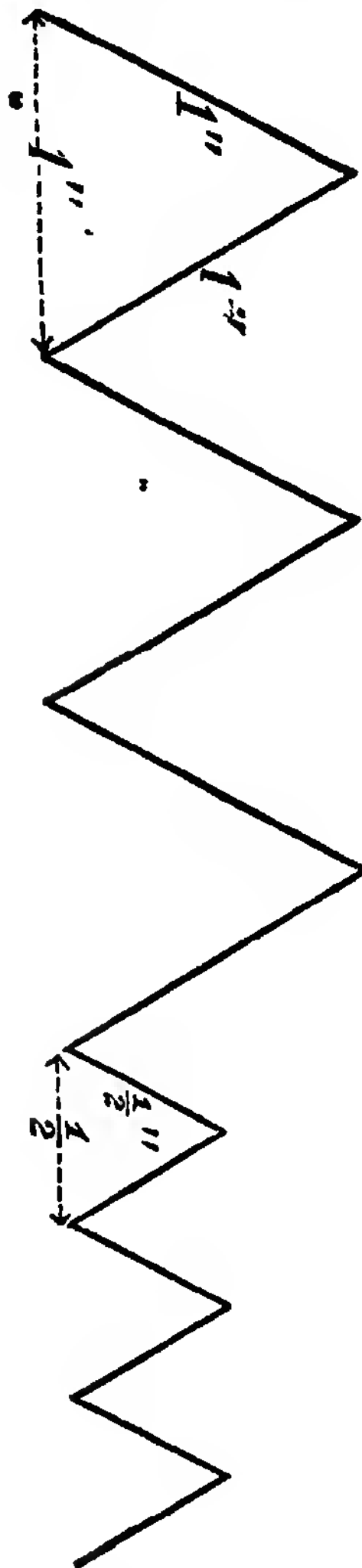


NOTE.—This figure also should be constructed as an exercise in drawing to scale, either on plain or squared paper.

The proper angles at which to bend the wire must be found by applying it to the drawing.

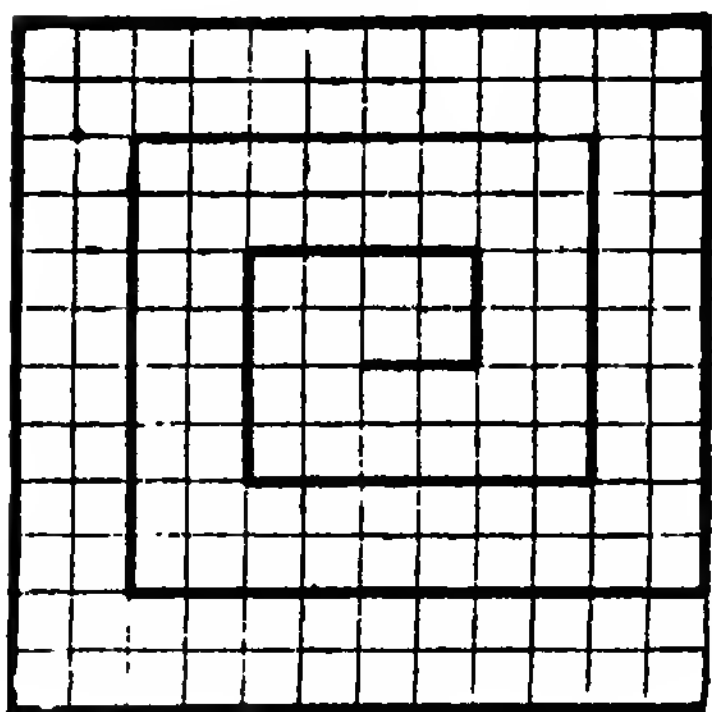
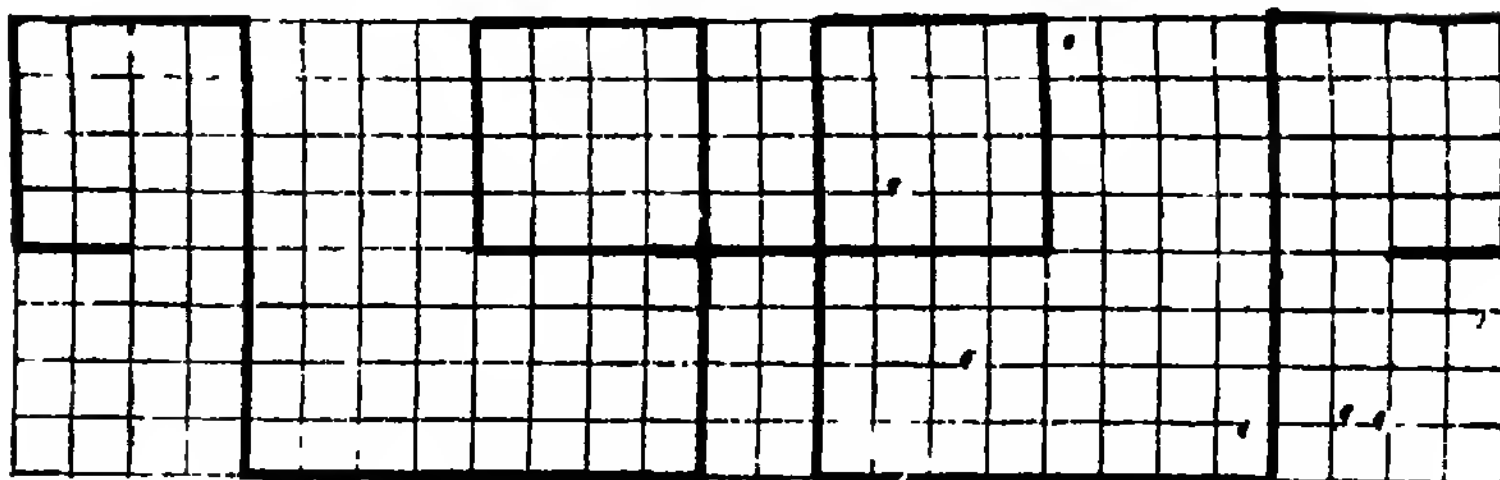
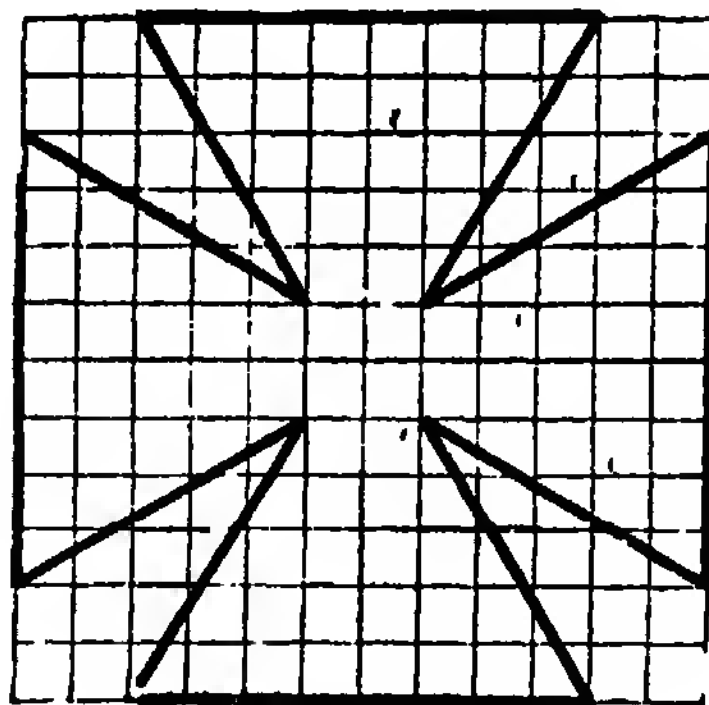
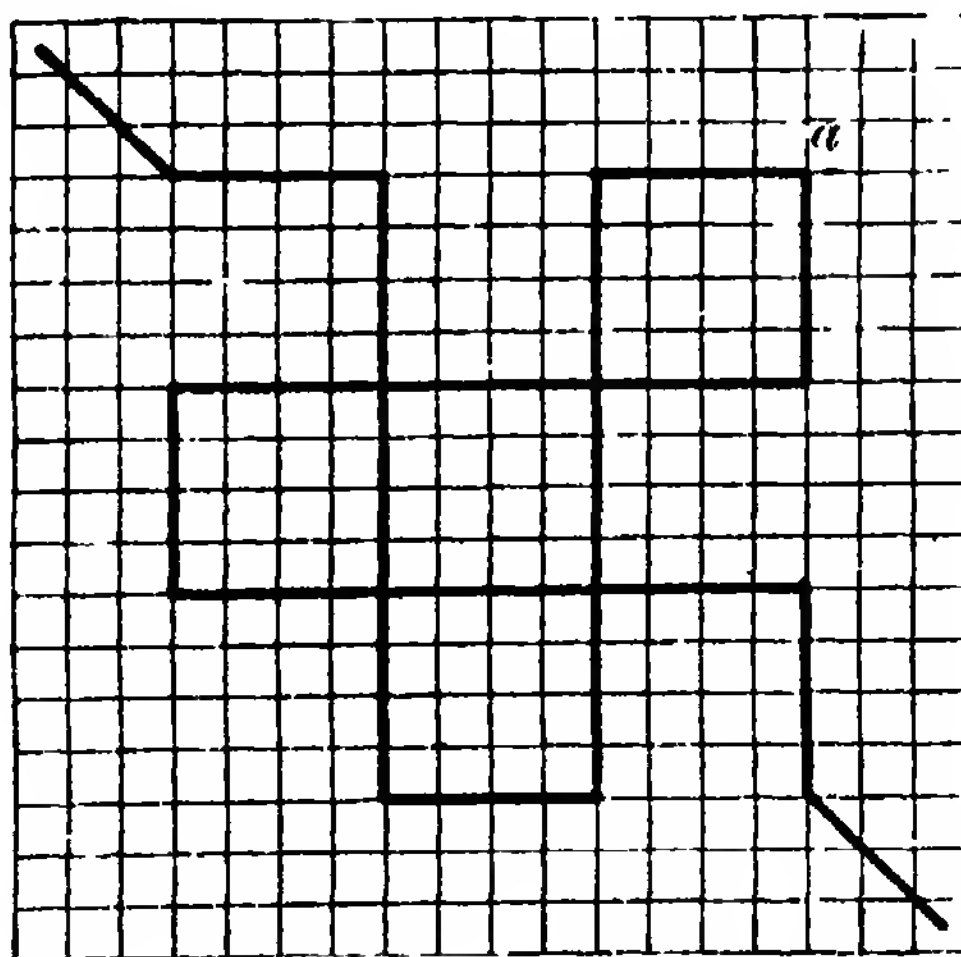
**Exercise X.**

**WIRE MODELLING.**



**NOTE.**—This exercise should be constructed in wire without either measurement or application of the wire to the drawing. The parallelism of the various lines should be pointed out as a chief feature to be secured.

The drawing may be made by means of the rule and set square.

**Additional Exercises in Wire Modelling.****B****C**

**NOTE.**—The figures are best drawn on squared paper.

In constructing Fig. D in wire, begin by bending wire at its middle point *a*;  
and in B begin by bending wire to form central parts of figure.

## EXERCISES IN CARDBOARD CUTTING.

(EXERCISES XI.—XX.)

THE second set of exercises in the present series deals with the cutting out of simple geometrical forms in cardboard with a sharp-pointed knife. (See *Notes M* and *N*, p. 190.)

The figures should first be accurately drawn in pencil on the cardboard (after having been previously practised on drawing paper, if necessary) by means of a ruler and set square or compasses, the drawing being done either from a verbal description or from a sketch on the blackboard, the actual dimensions being given in each case.

The cardboard to be cut should be laid on a smooth piece of board (or stout millboard), to save the desk from being cut. A steel rule (see *Note O*, p. 191) is firmly held close to the line along which the cut is to be made, and the point of the knife is then drawn along close to the rule. If the cardboard is not cut through completely the first time, care must be taken, in making a second or third stroke, to keep in the original groove.

In the figures of Exercises XVIII., XIX., etc., where a piece of cardboard has to be cut out from within an angle, it will be found best to make the cut *from*, and not *to*, the point of the angle.

Some or all of the figures cut out may have their edges bound with strips of coloured paper or bookbinder's cloth (see *Note P*, p. 191), which, if carefully done, will give them a more finished appearance. It is left to the teacher to choose which

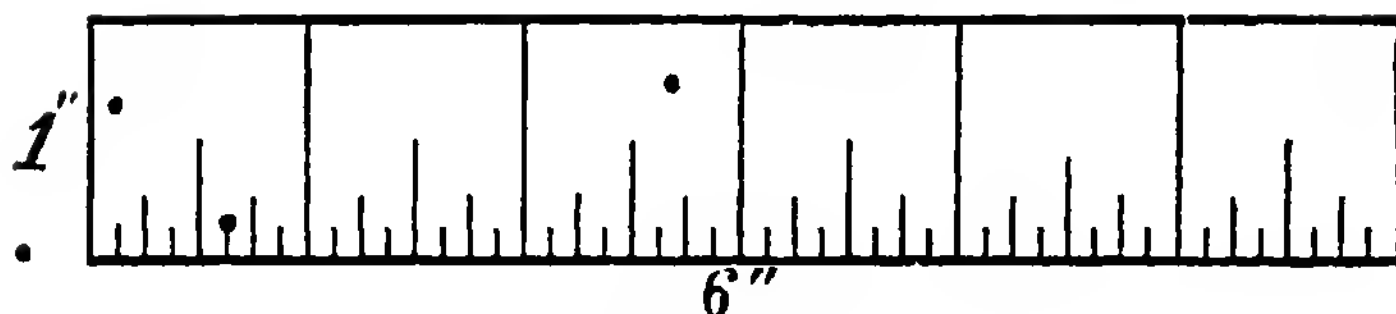
of the figures should be so bound ; in some cases permission to bind the model might be the reward for good work.

As the materials required and the method of work are the same for all the exercises in the set, it is not necessary to give a full description of each exercise.

The figures given in the following exercises are, in nearly all cases, drawn half the size indicated by the dimensions marked on them.

**Exercise XI.**

**CARDBOARD CUTTING—SIX-INCH RULE.**



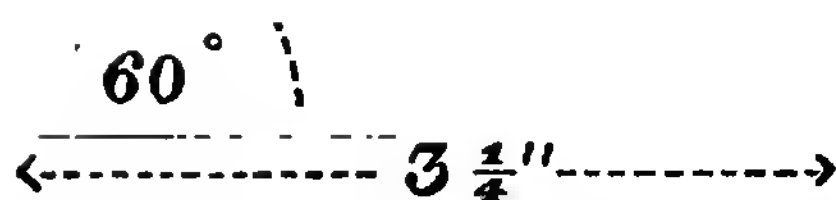
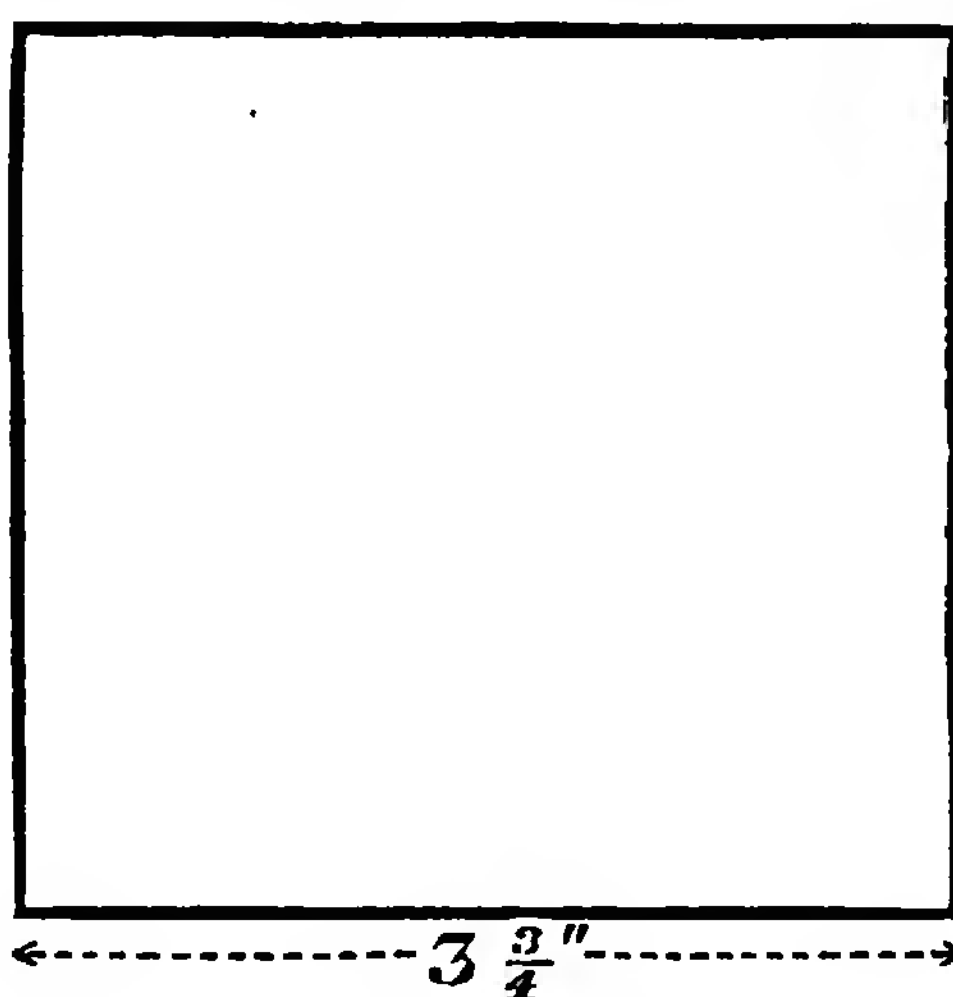
NOTE.—Piece of cardboard 8" × 6".

Cut strip 1" wide from *long* side of cardboard ; then cut off piece 1" long from each end (forming two inch-squares).

Mark strip with pencil successively into inches, half-inches, quarter-inches, and eighths.

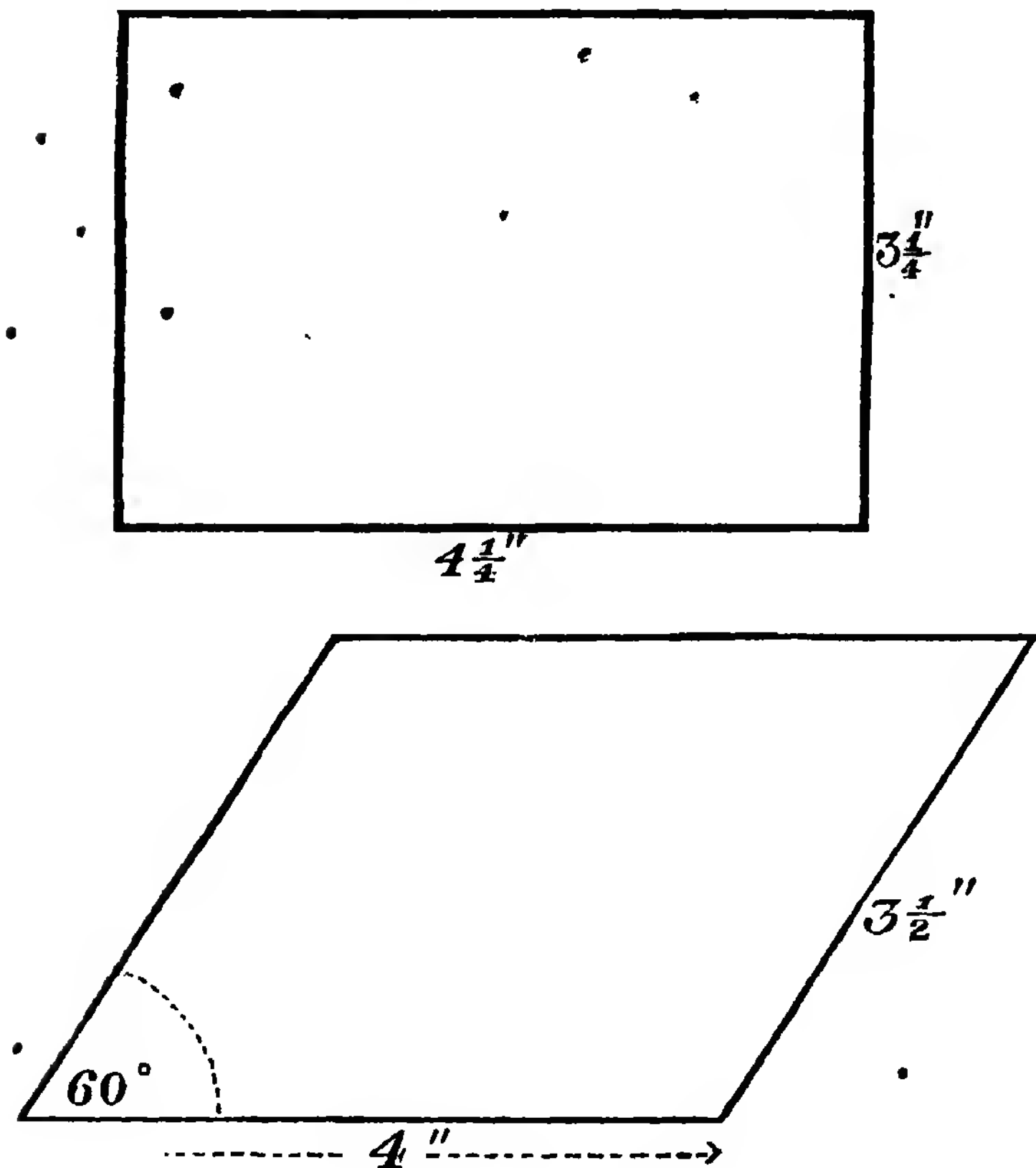
[The remaining piece of cardboard will be used in the next exercise.]



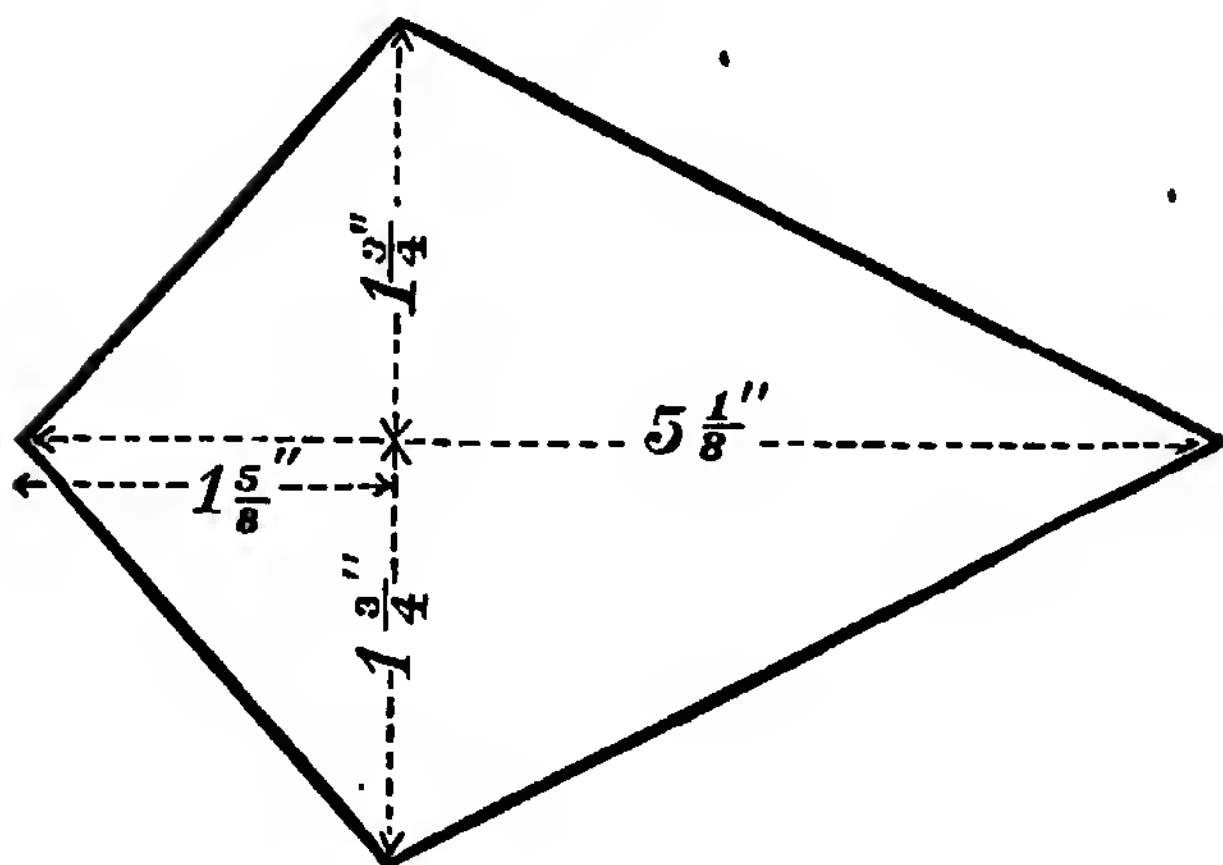
**Exercise XII..****CARDBOARD CUTTING—SQUARE AND RHOMBUS.****NOTE.**—Use the piece of cardboard left over from the last exercise.

**Exercise XIII.**

**CARDBOARD CUTTING—OBLONG AND RHOMBOID.**



**NOTE.**—Piece of cardboard  $8" \times 6"$ .

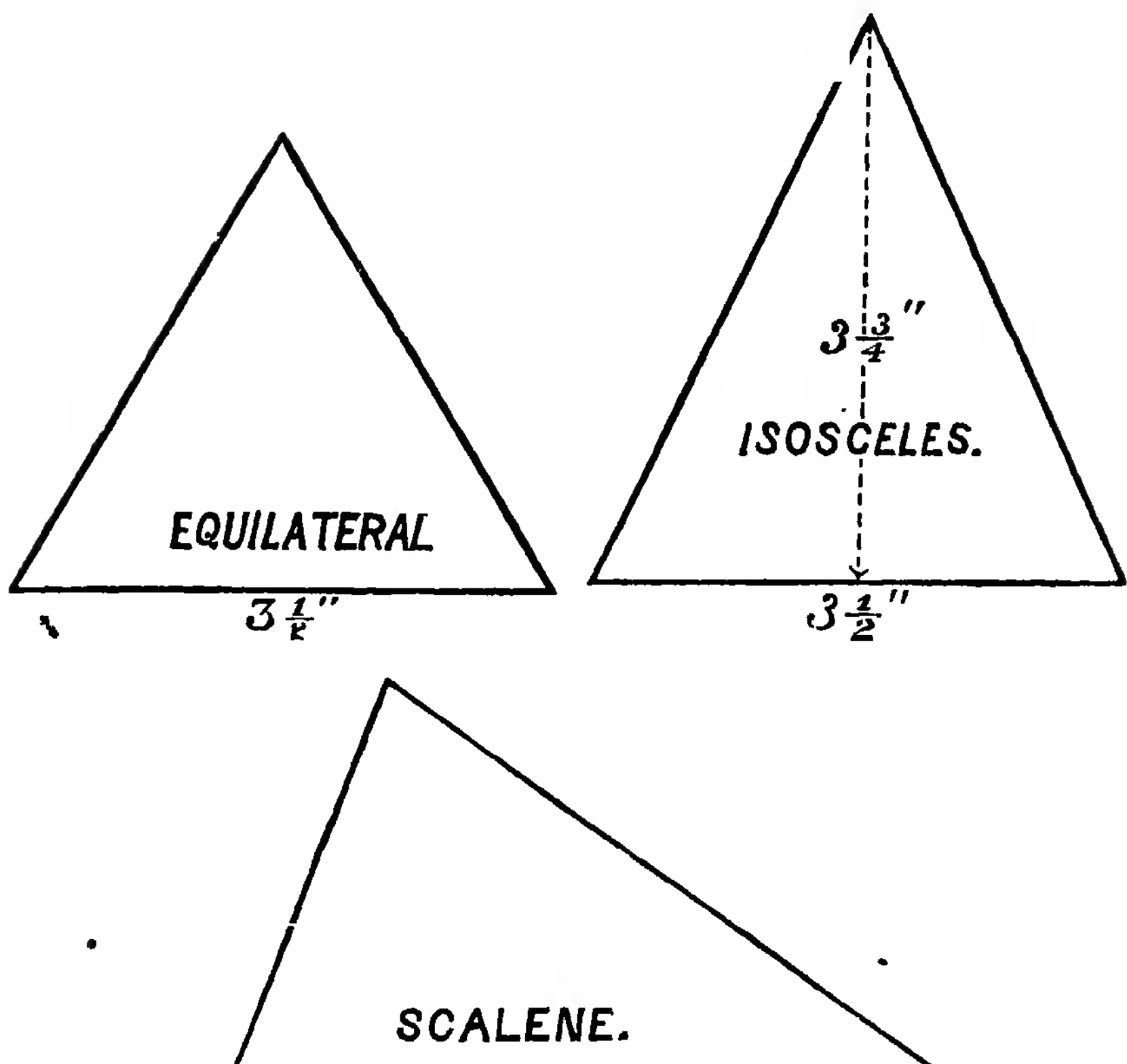
**Exercise XIV.****CARDBOARD CUTTING—TRAPEZIUM.**

**NOTE.**—Piece of cardboard  $6" \times 4"$ .

First draw the two diagonals at right angles to each other, and of proper length (longer one  $5\frac{1}{8}"$ , shorter  $3\frac{1}{2}"$ ); then draw lines joining their ends.

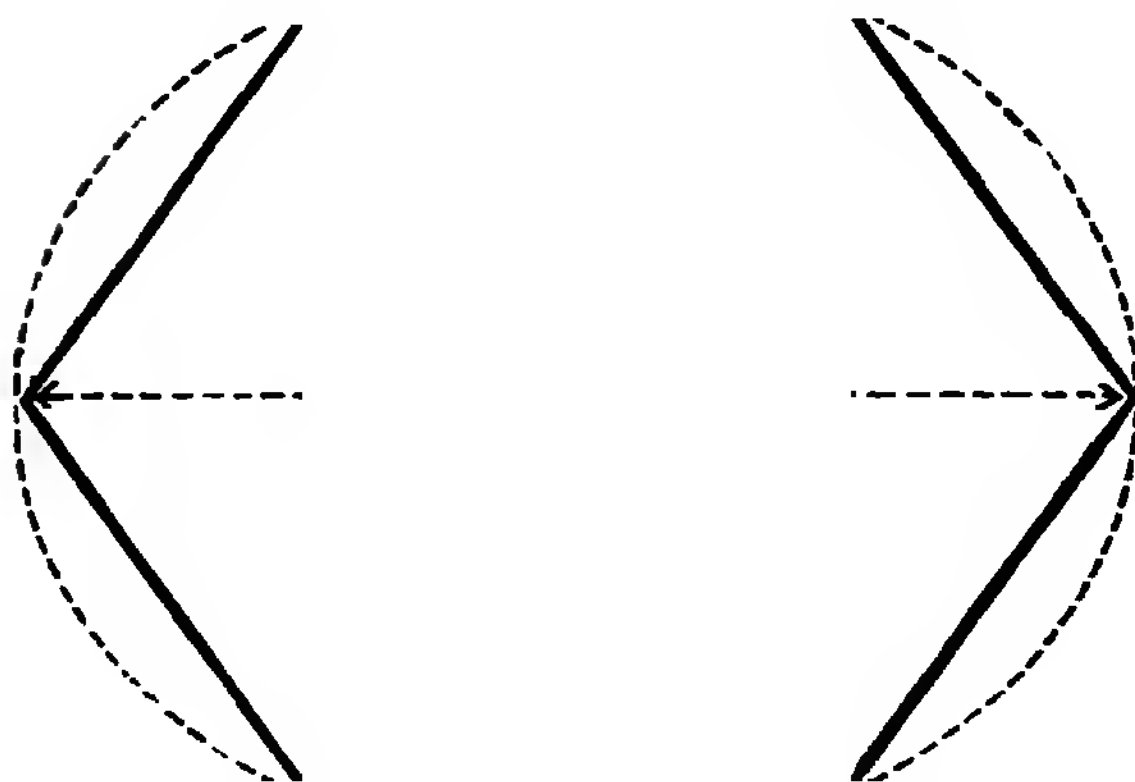
**Exercise XV.**

**CARDBOARD CUTTING—TRIANGLES.**



NOTE.—Piece of cardboard  $8'' \times 6''$ .

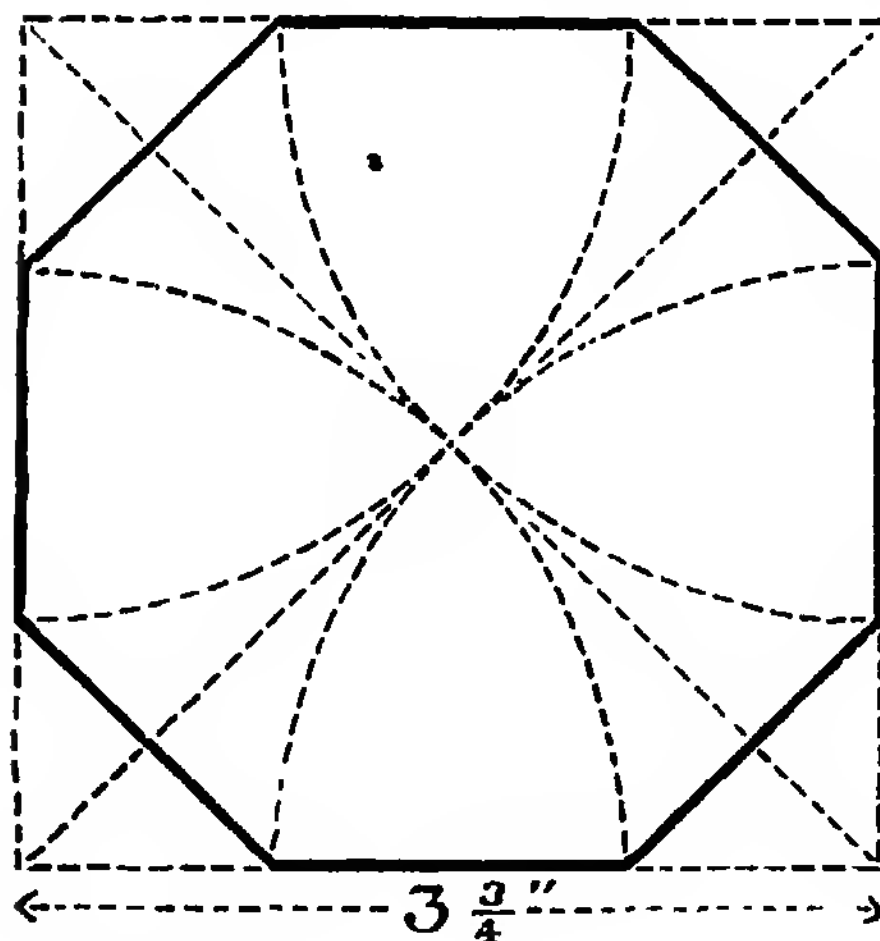
The scalene triangle might be cut out without being first drawn ; and then the sides carefully measured, and the dimensions marked on the card.

**Exercise XVI.****CARDBOARD CUTTING—HEXAGON.**

NOTE.—Piece of cardboard 6"  $\times$  4".

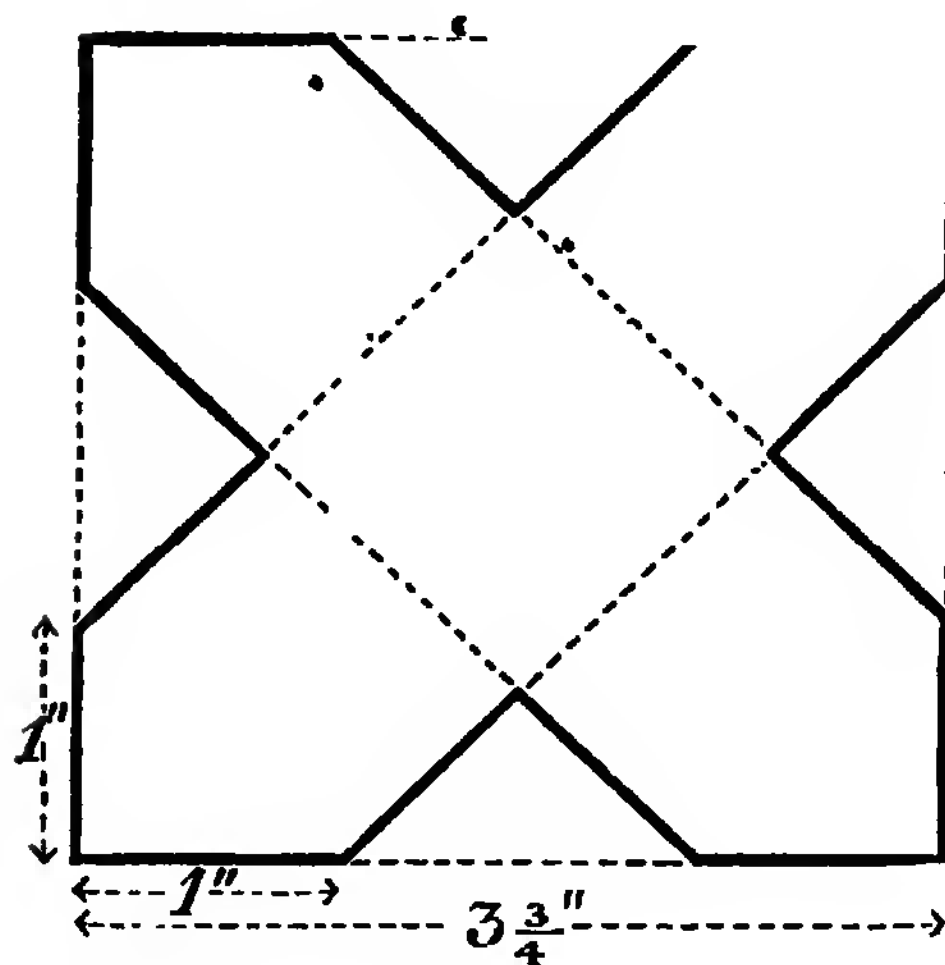
**Exercise XVII.**

**CARDBOARD CUTTING—OCTAGON.**



NOTE.—Piece of cardboard  $6'' \times 4''$ .

Construct octagon by first drawing square of  $3\frac{3}{4}''$  side, then drawing the diagonals, and with point of compasses on corners of square drawing arcs as shown in figure. Rule outline of octagon strongly before cutting.

**Exercise XVIII.****CARDBOARD CUTTING—CROSS.**

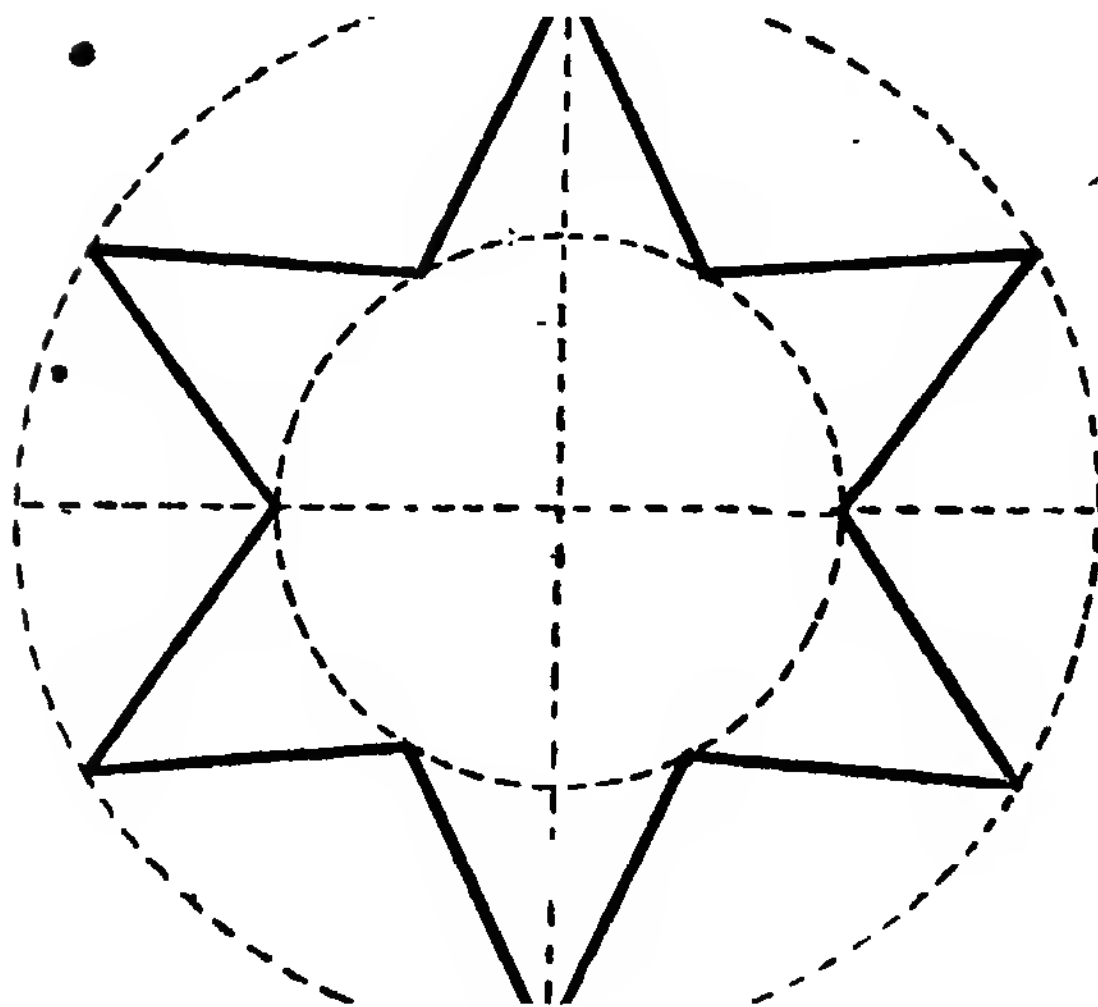
NOTE.—Piece of cardboard  $6'' \times 4''$ .

First draw a square of  $3\frac{3}{4}''$  side, mark off points  $1''$  from corners of square, and complete figure as shown.

Cut out the complete square first, and then the V-shaped pieces from the sides, cutting *from* the point of the angle.

**Exercise XIX.**

**CARDBOARD CUTTING—SIX-RAYED STAR.**



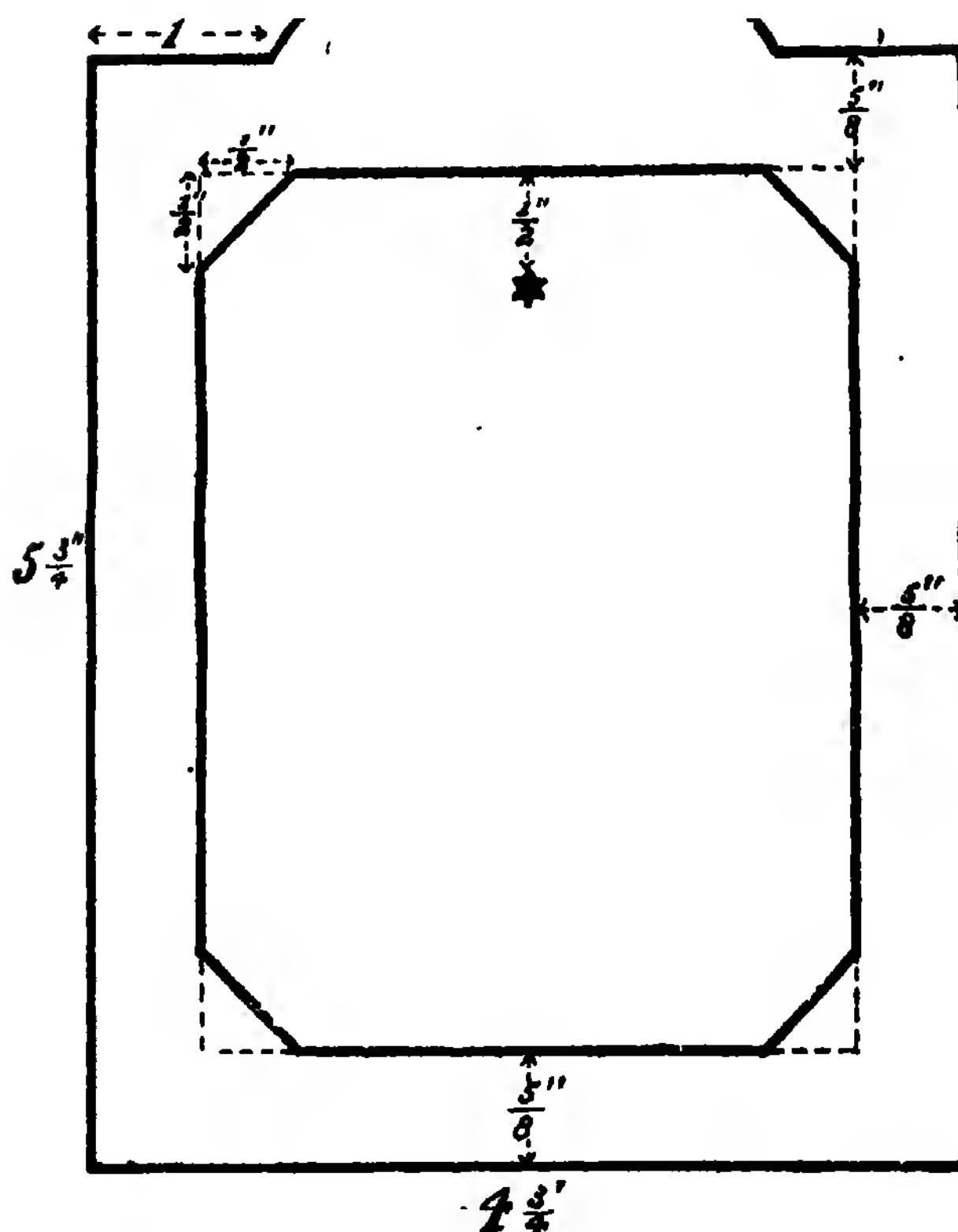
NOTE.—Piece of cardboard 6" × 4".

Draw outer circle 4" diameter, inner circle 2" diameter. Then draw two diameters at right angles.

Divide outer circle into six parts from end of one diameter, and inner circle into six parts from end of other diameter, as if about to construct hexagons.

Join points as in figure.

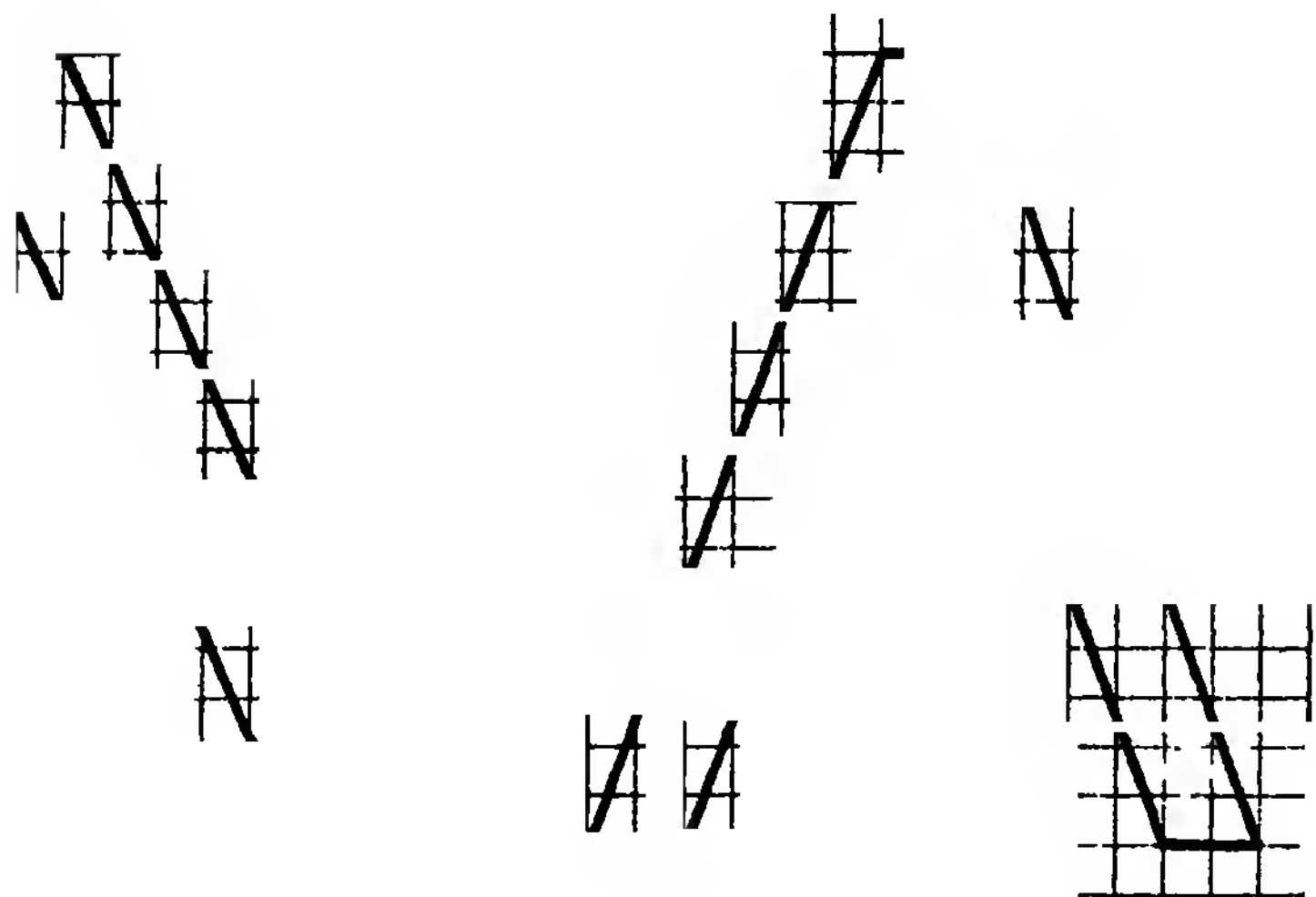
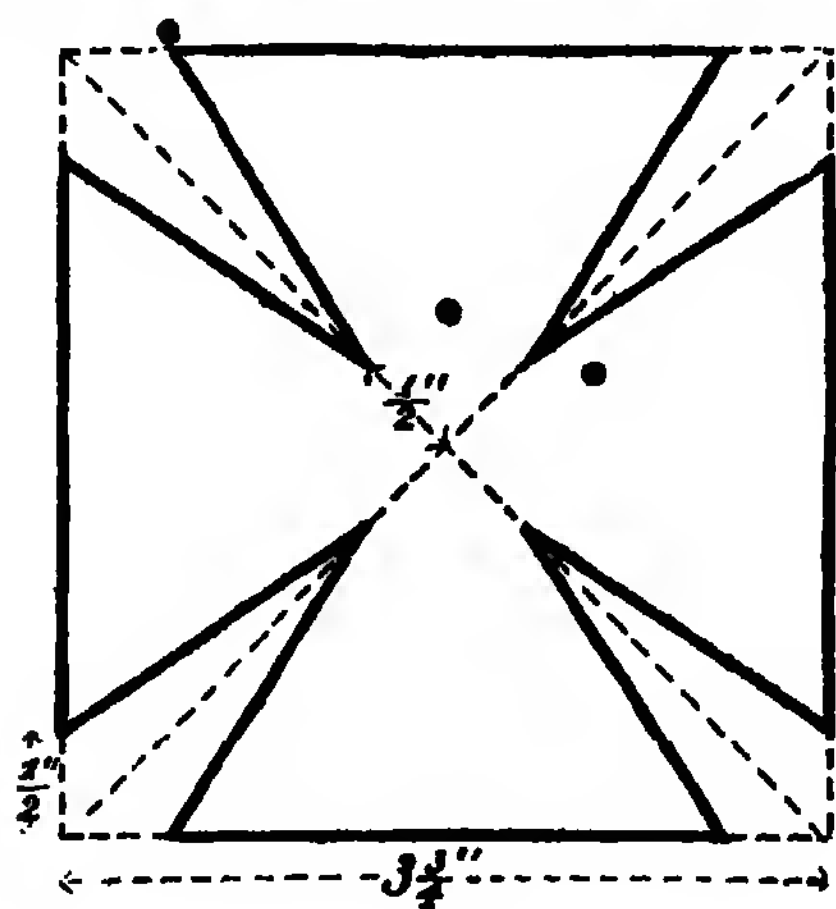


**Exercise XX.****CARDBOARD CUTTING—PICTURE FRAME**

NOTE.—Piece of cardboard 8" × 6".

Strike curve for top of figure with compasses from point marked \* as centre. Cut out middle piece of cardboard as neatly as possible to leave a hollow frame.

Additional Exercises in Cardboard Cutting.



NOTE —Other letters, T, H, E, V, etc., might be cut out from the pieces of cardboard left over from Exercise XXXIII. and other exercises in cardboard modelling.

## EXERCISES IN CARDBOARD MODELLING.

### (EXERCISES XXI.—XXX.)

THE third set of exercises in this series deals with the construction in cardboard of models, or simple objects having a more or less solid form, instead of being, as in the last set, mere plane geometrical figures.

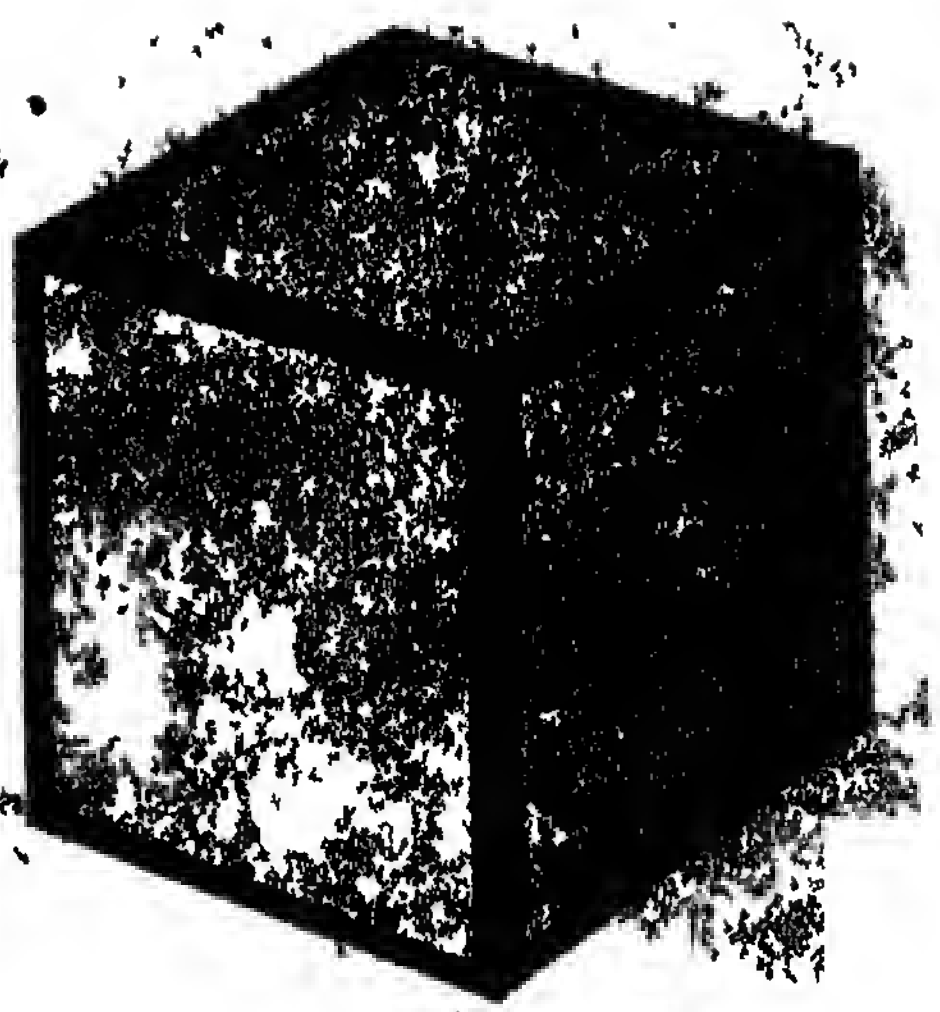
A plan, or “development,” has first to be drawn upon the flat cardboard in such a manner that, when the cardboard is bent along certain lines shown on the plan, the model or object is produced. In order to enable this bending to be done accurately and neatly, the cardboard is cut half-way through (*on the face which is to form the OUTER surface of the model*) along the line on which it has to be bent; and care must be taken that the knife does not cut so deeply into the cardboard as either to sever it entirely or to leave too thin a layer connecting the two parts. In the following drawings the lines along which these partial cuts are to be made are dotted, while the continuous lines indicate where cuts passing completely through the cardboard are required.

To obtain well-made models and objects, it is essential that both the drawing and the cutting should be as accurate as possible.

After having made the drawing to scale on the cardboard, showing the lines continuous or dotted as in the copy, the child should cut neatly through the *outer* lines of the drawing, so as to cut out from the sheet the piece of cardboard required for the model. Then the inner dotted lines should be half cut through—at first very lightly, and repeated until the proper depth is obtained. Then the cardboard should be carefully



XXII



XXIV







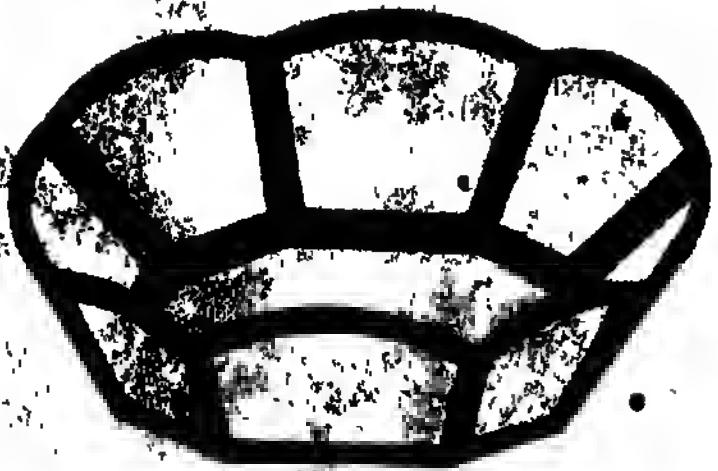
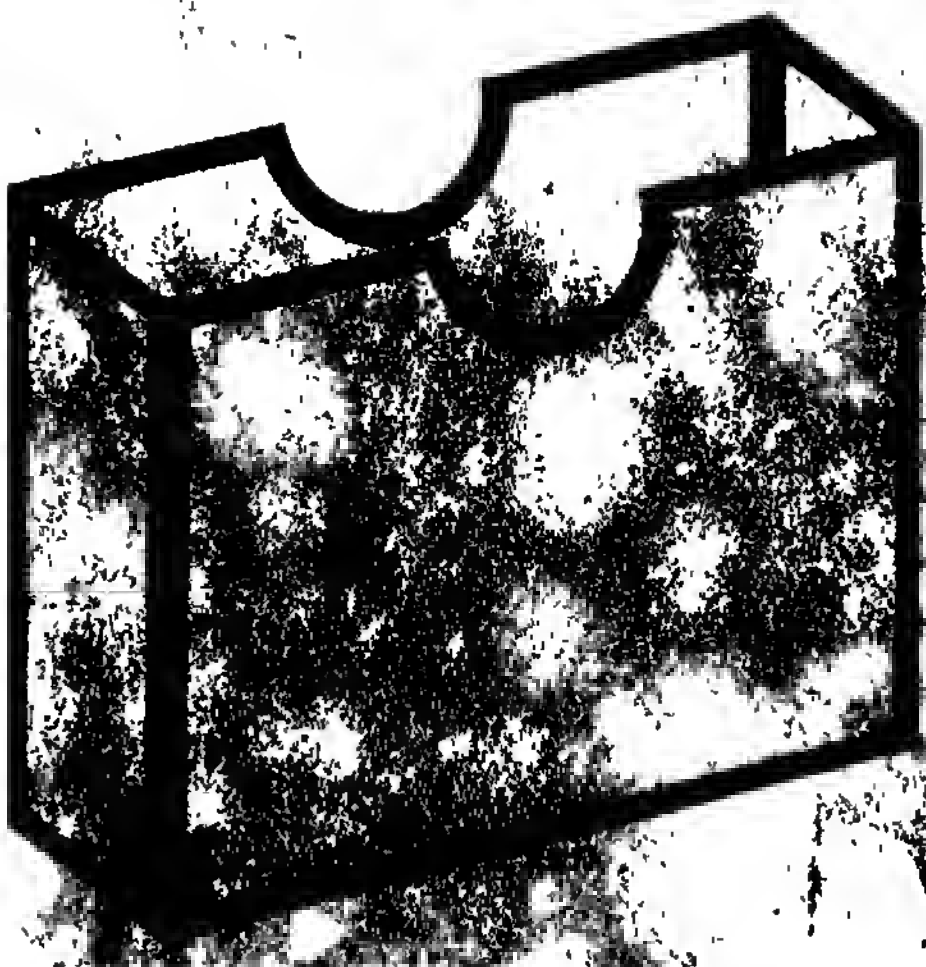
XXVI.



XXVII.



XXVIII.



XXX.

ber), where half cut, away from the side on which the cut has been made, and the cut edges, which come together in the model, joined by strips of gummed cloth. (See *Note P*, p. 191.) Other edges of the model may be similarly bound with strips of cloth, both for the sake of appearance and for additional strength.

Care and patience will be needed in binding the models, to produce nicely finished work. In some cases it may be found advisable to moisten and fasten down only half the width of the strip at one time; but in all cases it must be pressed neatly and firmly on the cardboard, and held in place until it properly adheres.

Some of the models might have their faces covered with the gummed coloured paper used in the exercises of the previous series, in which case the papering should be done before the models are bound.

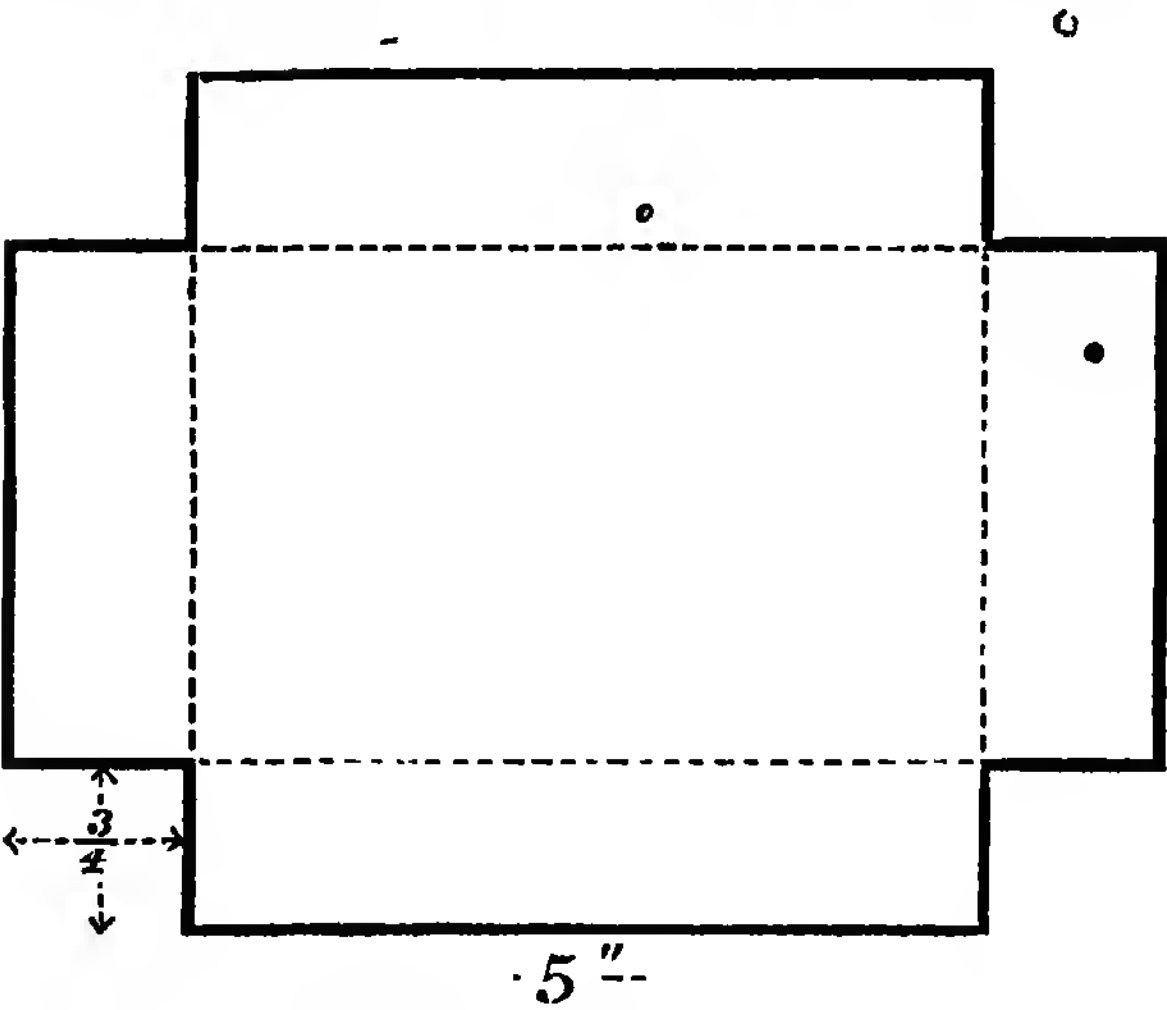
The forms of the various cardboard models are shown on Plates IV. and V. Many other exercises in cardboard modelling might readily be arranged by the teacher; e.g. a simple wall-bracket, a sliding match-box, a box with hinged lid, etc.

The figures in the following exercises are not drawn full size, but the actual dimensions required are marked on the drawings.



Exercise XXI.

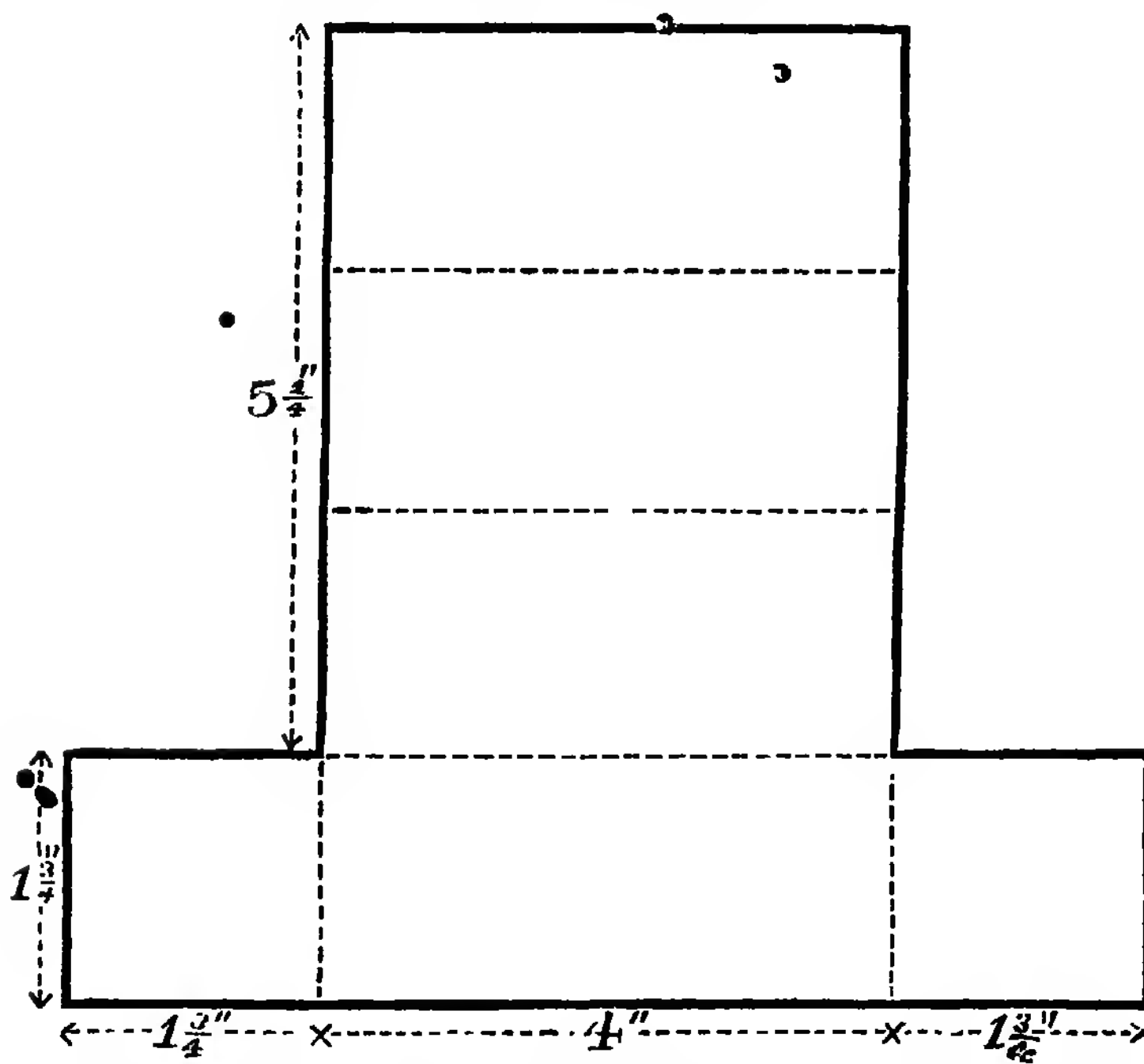
CARDBOARD MODELLING—RECTANGULAR TRAY.



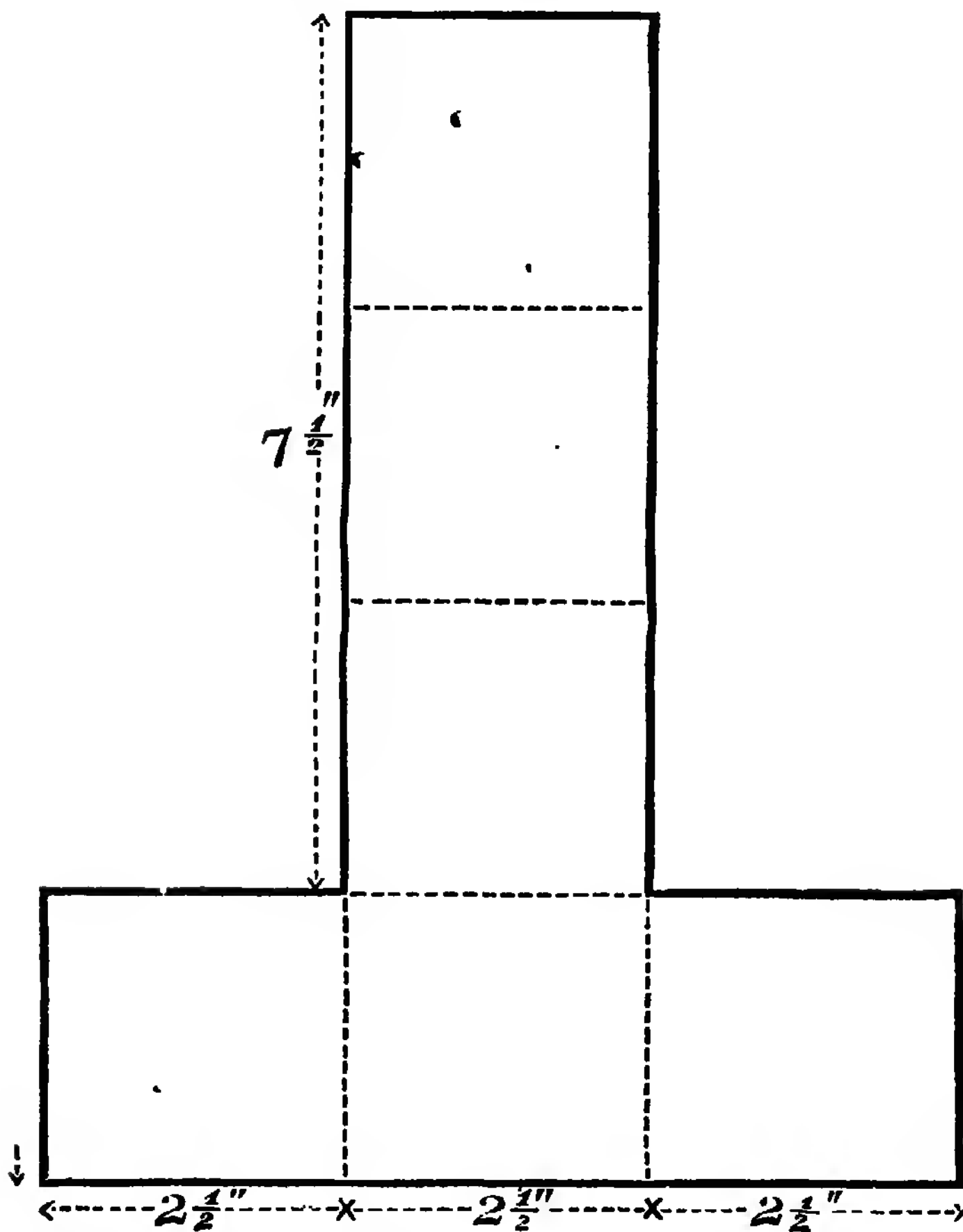
NOTE.—Cut piece of cardboard required from end of piece 12" x 8", and lay aside remainder for use in the next exercise.

• Exercise XXII.

CARDBOARD MODELLING—SQUARE PRISM.



NOTE.—Use the piece of cardboard left from Exercise XXI.

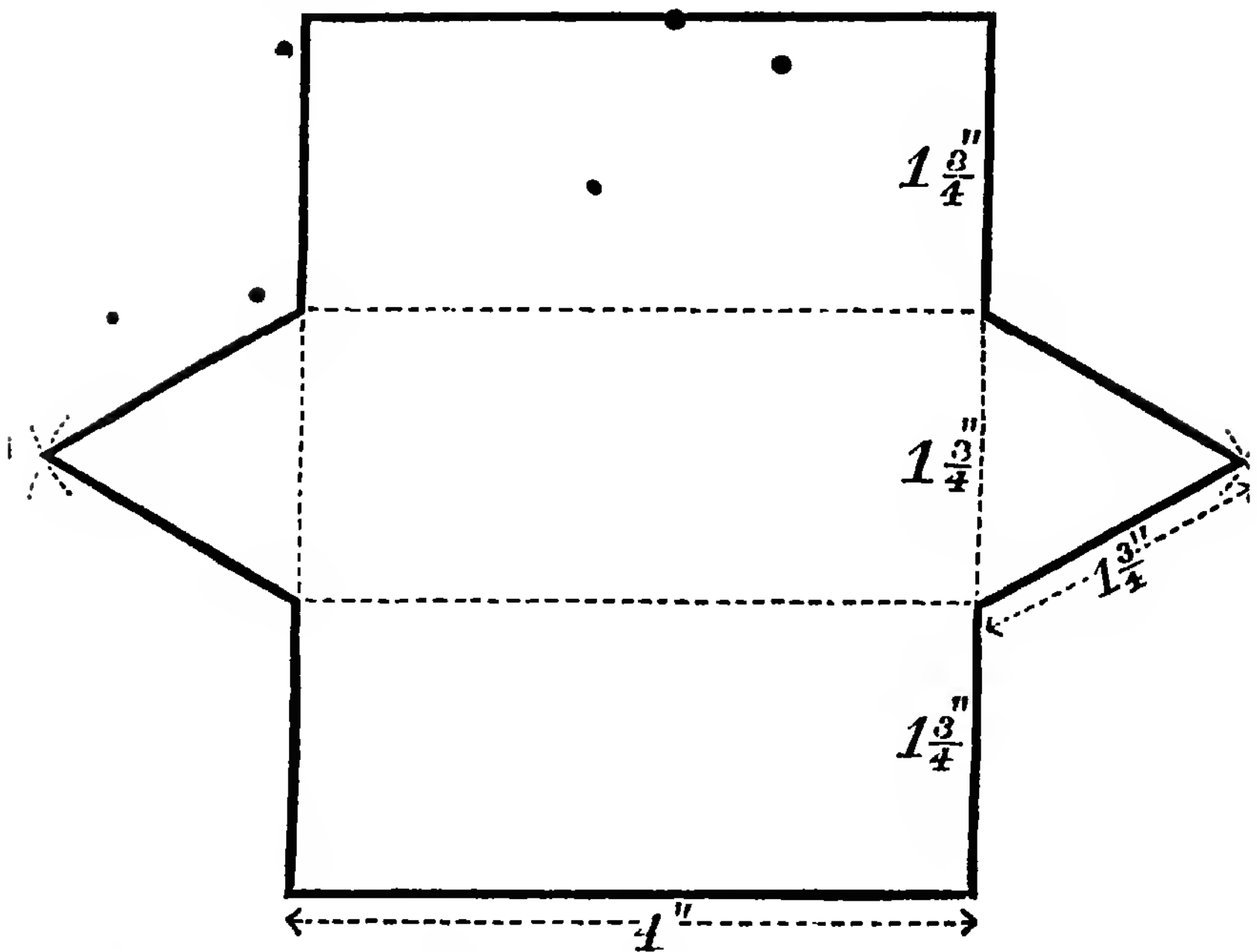
**Exercise XXIII.****CARDBOARD MODELLING—CUBE.**

NOTE.—Piece of cardboard  $12" \times 8"$ .

[The remaining pieces of cardboard might be used for cutting various capital letters. (See p. 217 )]

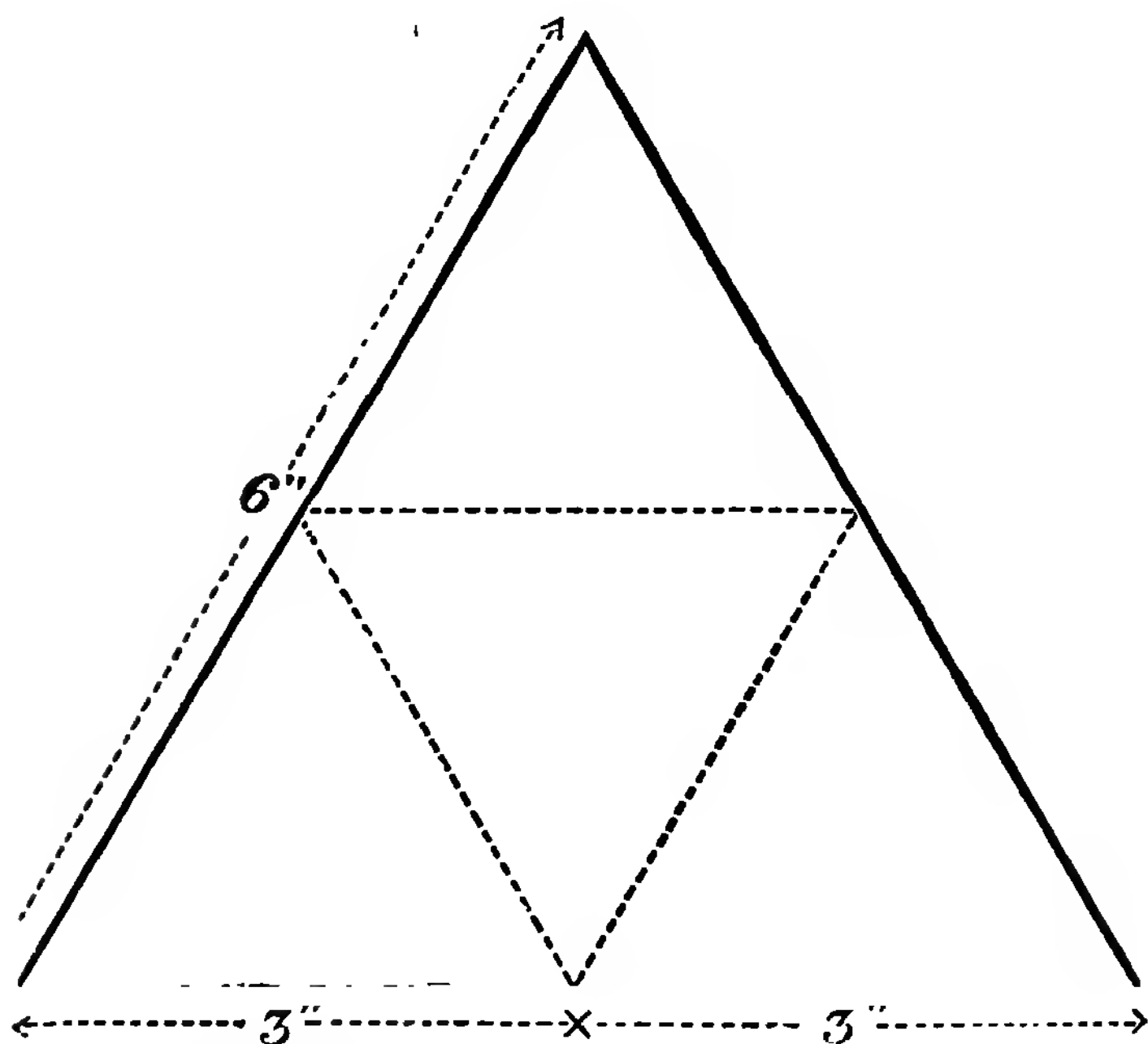
• **Exercise XXIV.**

**CARDBOARD MODELLING—TRIANGULAR PRISM.**



NOTE.—Piece of cardboard 8" × 6".

The triangles are equilateral.

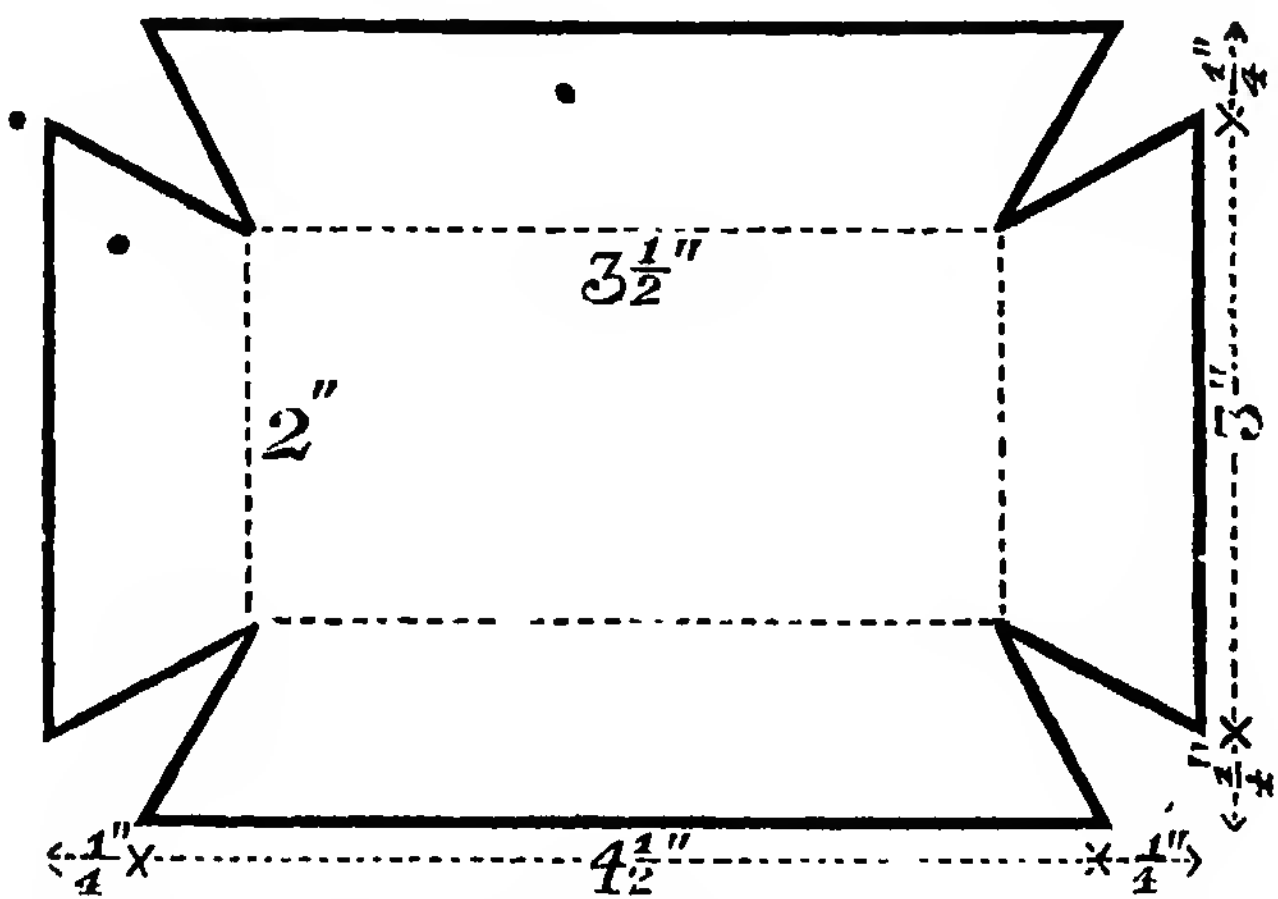
**Exercise XXV.****CARDBOARD MODELLING—TETRAHEDRON.**

**NOTE** —Piece of cardboard 8"  $\times$  6".

The large triangle is equilateral, and the dotted lines join the middle points of the sides, forming four smaller equal and equilateral triangles.

Exercise XXVI.

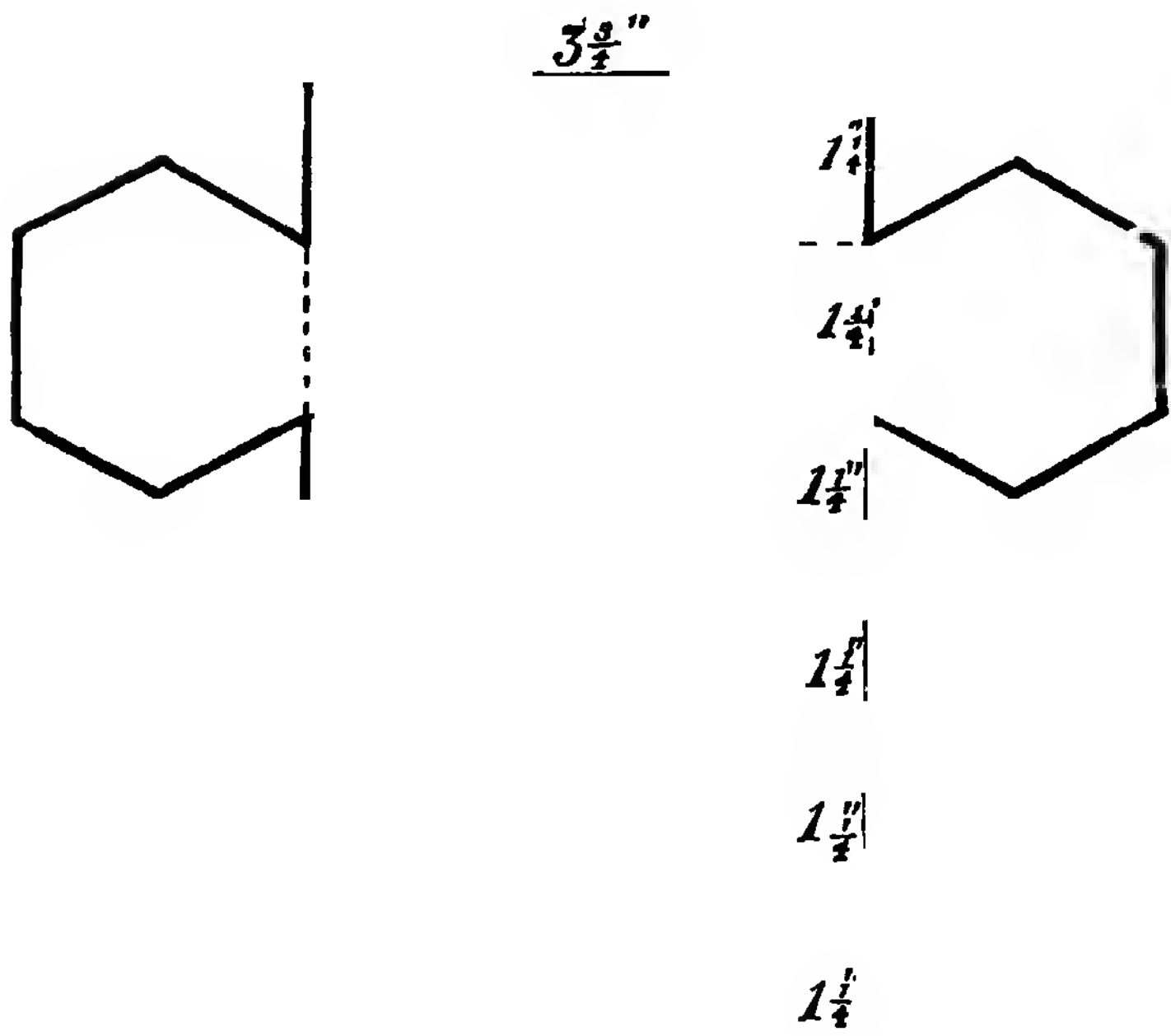
CARDBOARD MODELLING—TRAY WITH INCLINED SIDES.



NOTE.—Cut piece of cardboard required from end of piece 12" x 8", and lay aside remainder for next exercise.

Exercise XXVII.

CARDBOARD MODELLING—HEXAGONAL PRISM.

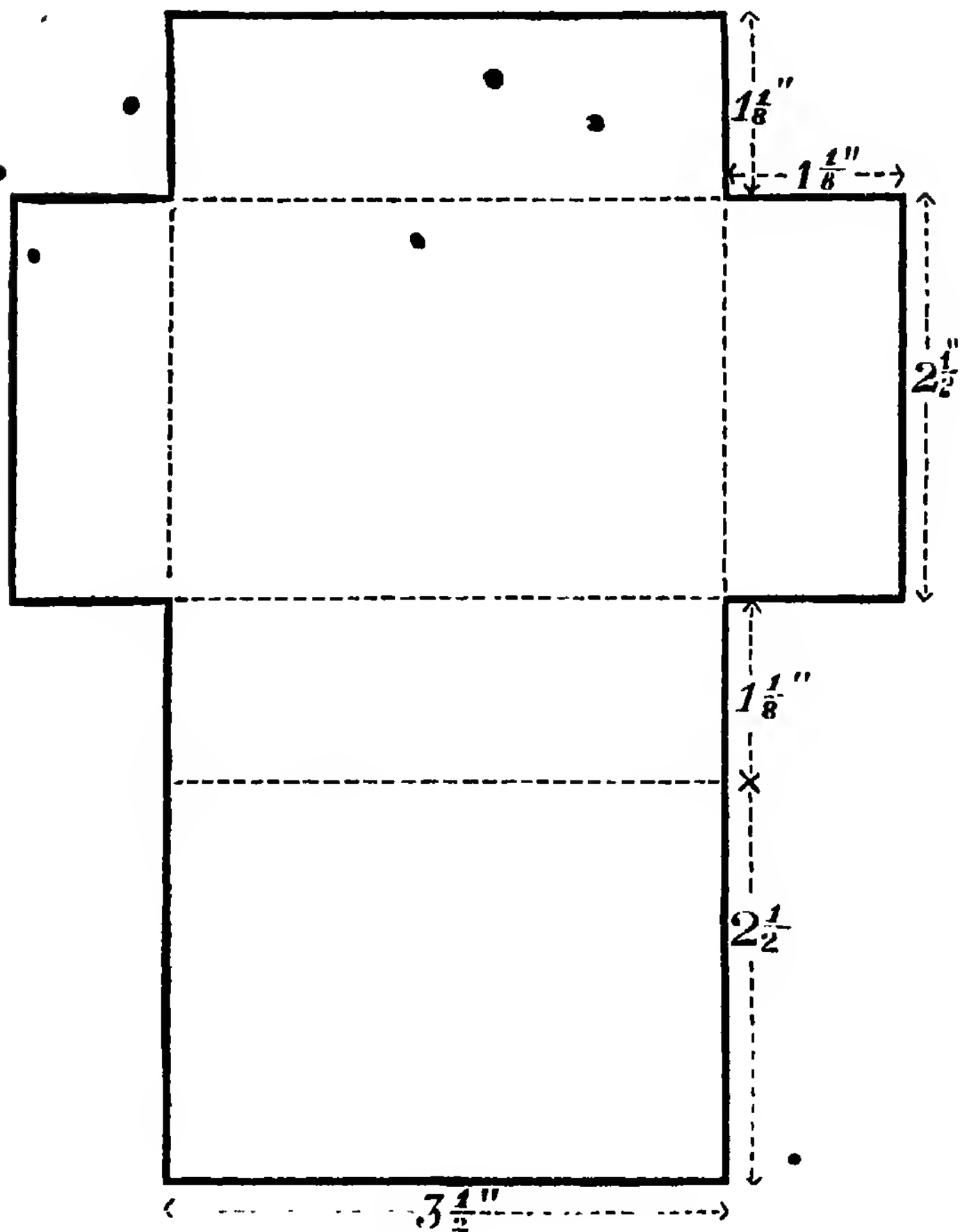


NOTE.—Use piece of cardboard left from Exercise XXVI.

Construct the hexagon at each side on any one of the shorter sides of the rectangles, by first drawing the circumscribing circle, and then marking off the points on the circumference.

Exercise XXVIII.

CARDBOARD MODELLING--RECTANGULAR PRISM.



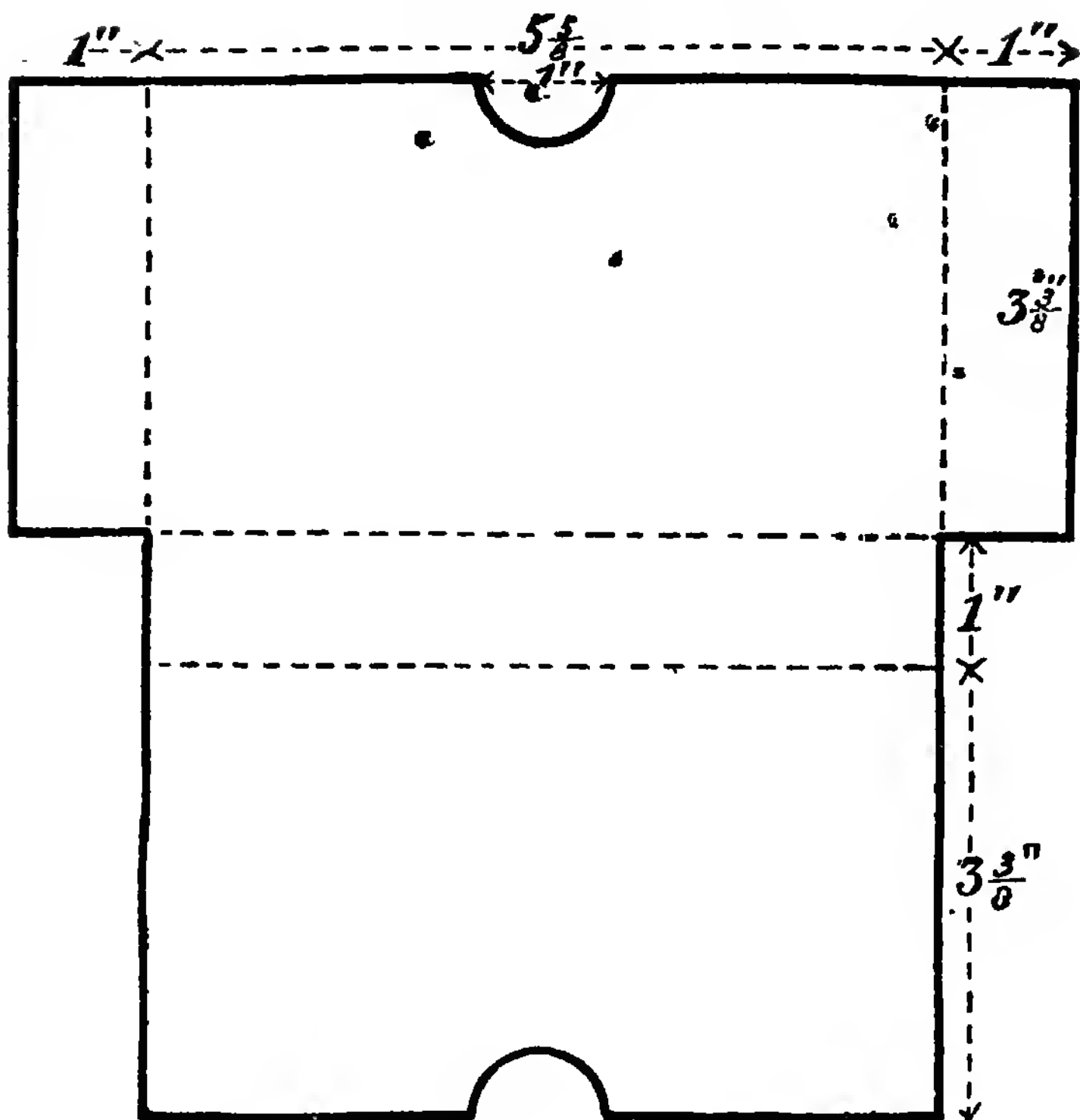
NOTE.—Piece of cardboard 8" × 6".

Point out, on previously constructed models, before the exercise is begun, how this prism differs from the square prism of Exercise XXII.



**Exercise XXIX.**

CARDBOARD MODELLING—ENVELOPE CASE.

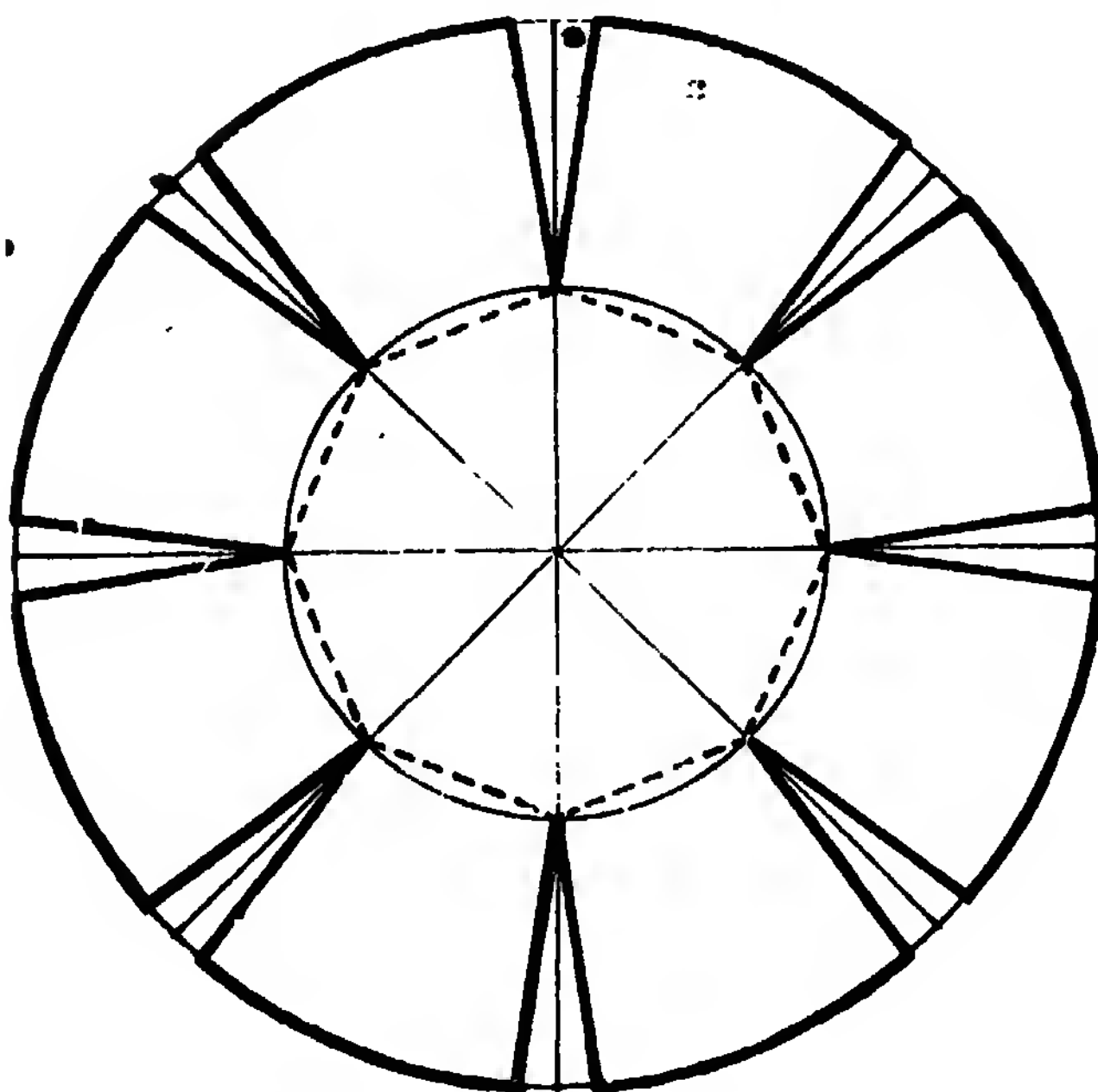


NOTE.—Piece of cardboard 12" × 8".

If the children find the semicircular notch too difficult to cut out neatly, a square one may be substituted.

Exercise XXX.

CARDBOARD MODELLING—OCTAGONAL TRAY WITH INCLINED SIDES.



NOTE.—Piece of cardboard 8" x 6".

The construction lines used in drawing the pattern are shown by faint continuous lines in the illustration. The diameter of the outer circle is  $5\frac{1}{2}$ ", of the inner  $2\frac{1}{2}$ ". The small pieces cut out measure  $\frac{1}{4}$ " on the outer circle.

The outer edges of the tray may be either curved, or, if the children find the cutting in that case too difficult, the edges may be ruled and cut straight.







